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" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*" To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

THURSDAY, NOVEMBER 1, 1900.

A NEW FRENCH FORESTRY TEXT-BOOK.

Les Forêts. Par L. Boppe, Directeur honoraire de l'Ecole Nationale des Eaux et Forêts de Nancy, et Ant. Jolyet, chargé de cours à l'Ecole. Pp. xi. + 488. (Paris: J. B. Baillère et Fils, 1901).

WITHIN the last ten years the course of instruction at Nancy has been considerably modified. The school is attended by some foreign students, who, as well as a few occasional private French students, are admitted without any regular examination. Formerly, students intended for service in the State and Communal forests of France passed a preliminary competitive examination in the subjects usually taught at a Lycée, including physics and chemistry. A knowledge of botany, entomology and geology, however, was not required of them, these subjects being taught *ab initio* at Nancy; in those days the marks obtained for forestry unduly overshadowed those given for natural history, and only a few devoted naturalists were to be found among French forest officers. Forestry teaching at Nancy also was much too dogmatic, and not sufficiently based on experimental results.

At present, French forest students who are intended for the service of the State come from the *Institut National agronomique*, and must obtain a diploma there before being admitted to Nancy. About eighty students enter the Institut agronomique annually, while the number of State students at Nancy is limited to twelve per annum, the last twelve men admitted to Nancy standing 1, 3, 6, 7, 9, 10, 15, 21, 24, 26, 39 and 48 at the final examination of the Institut agronomique. Nancy students thus at present possess a considerable knowledge of agriculture and experimental natural science; they also get pecuniary allowances from the State, so that admission to the French forest service is open to a wide field of French citizens, and is not confined, as are some of our own public departments, to a restricted class of men, who have sufficient means to pay the high cost of training involved, this restriction injuriously affecting the intellectual standard of the departments.

Forestry teaching at Nancy has responded admirably to the higher attainments of the present class of students, and it is a real pleasure for one who studied there nearly thirty years ago to note the excellence of this new text-book of sylviculture.

In it a forest is described as a complex organic whole, composed of a porous and friable humous soil, covered with dead leaves and moss, wherever the shade is too great for vegetation other than saprophytes; where, however, the mature crop of trees has been thinned or cleared with a view to natural regeneration, the soil is soon overgrown with grasses or other herbaceous plants, as well as brambles, bushes and shrubs, which, together with the young plants of the valuable forest species, form a complex mass from which saplings, poles and trees gradually emerge, and compose a new crop, either as coppice or high forest. This evolution of a new crop from an old one requires considerable skill on the part of a forester, and it is only by carefully observing and following nature that success is obtained. Each forest species makes different demands on soil and climate and requires in its young state various degrees of protection against hostile meteoric influences, injurious plants and animals.

In France natural regeneration, either by seed or by coppice shoots, is the chief means of reproducing a forest, and human interference with the growing forces of nature is reduced to a minimum. The chief classes of French indigenous high forests, reproduced by seed, consist of oak, beech or silver-fir; maritime pine in Gascony; larch and spruce in the Alps, the latter also growing in the Jura with beech and silver fir; *Pinus sylvestris* (for which our name of Scotch pine is far too local, and as a substitute for which I would suggest the name red pine) is indigenous in France only in mountainous regions, but has been extensively planted on poor sandy soils in the lowlands. There are extensive coppices of mixed underwood with oak and other standards, and of holm oak with Aleppo pine standards, in Provence. The holm oak (*Quercus Ilex*) prefers calcareous soils, and is replaced in the south of France, on siliceous soils, by the two very valuable cork oaks (*Quercus Suber* and *Q. occidentalis*), the latter differing from the former by its habitat near the Bay of Biscay, and by its taking two years to mature its

acorns. Both these oaks are usually grown isolated in vineyards for their cork. *Quercus Tozza* is restricted to the south-west of France, where extensive coppices of it are grown for fuel. Hornbeam is abundant in the north-east, chiefly in coppice-with-standards; its abundance in Epping Forest probably dates from the time when England was connected by land with the Continent. Other species of forest trees, such as ash, alder, sweet-chestnut, sycamore, willows, poplars, birch, lime, elms, &c., are either confined to special soils over small areas, or disseminated in forests of the principal species that have been already mentioned. Maps are given in the text-book showing the geographical distribution of the principal trees.

There is an excellent chapter on the action of trees on one another, and on the value of shade-bearing species, such as beech, as auxiliaries to the more valuable light-demanding trees, such as the pedunculate and sessile oaks, the former being chiefly grown in the lowlands on deep, moist or even wet soils, as standards over coppice, and the latter with beech in high forests on the hills. Both these oaks, as well as the holm oak, are also extensively grown in coppice woods, chiefly for their bark, as tanning material.

A good account is given of the nature of forest soil, and the necessity of preserving the dead leaves to form humus is strongly insisted on. It has been proved by Grandeau and Henry, two of the Nancy professors, that besides serving as food for earthworms and other organisms, the activity of which keeps the soil porous, friable and superficially rich in nutritive mineral matter, dead leaves fix atmospheric nitrogen to the extent of 12–20 lbs. per acre annually. To deprive the forest of its dead leaves is like robbing a farm of its dung.

The evolution of a crop of trees by natural regeneration is well described, the account of coppice-with-standards being probably more complete than in any other text-book. The cultural methods to be followed when once the new crop is established are also well explained and chiefly consist of cleanings and thinnings. The authors are strongly opposed to the pruning of forest trees, and consider that drainage is very rarely required. Their remarks on these points should be read. Among sylvicultural systems yielding even-aged high forest (*futaie regulière*), the clear-cutting system (*procédé par coupe unique*), which is so extensively followed in parts of Germany for crops of spruce or red pine, is employed in France only for maritime and Aleppo pines. The cones of the pine trees adjoining a clearing produce abundance of seed, which at once stock the ground, provided the felled material is rapidly removed, and the seedlings of these trees are so vigorous and hardy against drought, that they soon dominate the mass of bushes and weeds springing up around them.

The system under which a mature crop is gradually removed (*procédé par coupe successive*), termed by Dr. Schlich shelter-wood compartment system, is that commonly employed in French high forests. It gives admirable results in oak and beech woods, but its application to silver-fir is not so successful, as silver-fir grows better when the larger trees are surrounded by an irregular undergrowth of beech and silver-fir.

The selection system (*jardinage*) similar to that employed in the Chiltern Hills for beech, is much used in France for silver-fir, chiefly in communal and private forests, and in State forests in mountainous districts, where it affords the best protection against denudation of the slopes.

About 70 pages of the book are devoted to an accoun of possible injuries to the forest by men, animals, plants and meteoric influences. This really constitutes the subject of Forest Protection, and is usually dealt with apart from sylviculture in German and English forestry text-books. One hundred and sixty pages at the end of the book treats of artificial reproduction, and resemble the account of sowing and planting usually given in other good sylvicultural works. This part of the book terminates with an account of exotic trees, the introduction of which is not viewed in France with nearly so much interest as with us, although the subject is very judiciously treated in the present volume.

The book is profusely illustrated by reproductions of photographs chiefly taken by Nancy students during their summer tour; it forms a highly valuable contribution to forestry literature, and is certainly the best account of French sylviculture that has yet appeared. There is a good table of contents, but no index, the omission of which is to be regretted. W. R. FISHER.

TOPOGRAPHIC SURVEYING.

Topographic Surveying. By Herbert M. Wilson. Pp. 884. (New York: Wiley and Sons. London: Chapman and Hall, 1900.)

MR. WILSON'S book is comprehensive, clear and well illustrated, and contains much information of practical use to the surveyor and explorer, which is not usually found in works on surveying and map-making. Its author is a member of the staff of the United States Geological Survey, and his remarks on the methods and processes of that Survey are therefore of special interest.

The Geological—which is virtually a topographical—Survey of the United States is a work of great magnitude, and the manner in which the staff engaged upon it have met the numerous technical, transport and other difficulties that have arisen during its progress is most interesting. It was laid down as a general principle that no part of the country should be surveyed in greater detail, or at greater cost, than was necessary for the purposes which the resultant map was intended to subserve. This involved a rapid and economical survey of a vast extent of country within reasonable limits of error. The method adopted

"consists of a combination of trigonometric, traverse and hypsometric surveying to supply the controlling skeleton, supplemented by the 'sketching in' of contour lines and details by a trained topographer. In this method the contour lines are never actually run out, nor is the country actually cross-sectioned."

The instruments used vary with the nature of the country. For geodetic work, a combination transit and zenith telescope of special pattern (p. 726) has been found most convenient. Primary bases are measured with steel tapes, with an average probable error of 1/300,000, in from seven to ten days, at a cost of 20*l*. to 40*l*.; whilst the bases of the U.S. Coast and Geodetical Survey have

a probable error of 1/1,000,000 to 1/1,500,000, take from two to six months to measure, and cost from 500*l.* to 2600*l.* The observations for the primary triangulation are made with an 8-inch direction theodolite, the average rate and cost being six stations per month and 3*s.* 7*d.* per square mile, and the average probable error of the triangulation 1/40,000. The averages of the Geodetic Survey are three-fourths of a station per month, from £2 to £6 per square mile and the probable error 1/150,000. For filling in the detail the essential instruments are the plane-table and telescopic alidade (p. 156). The horizontal distances are obtained, according to circumstances, by triangulation with the plane-table, by stadia and odometer measurements, by chaining, and by pacing. The altitudes are dependent upon primary lines of levels run with a precise spirit-level (p. 328), and having a probable error in feet $= \cdot 02 \sqrt{\text{distance in miles}}$; on angles of elevation and depression at the principal trigonometrical stations, on secondary lines of spirit-levels and on aneroid observations. The topographical features are represented on the map by contour lines sketched by eye with the assistance of an aneroid, and great importance is attached to the quality of the sketching. This depends upon the artistic and practical skill of the topographer, or upon his ability to make correct generalisations, and decide upon the amount of detail which should be omitted or preserved so as to bring out, on the selected scale, the predominant features of the country surveyed. In this work, as the author justly remarks, great proficiency "can only be attained after years of experience." He also rightly holds that the topographer should have a sufficient knowledge of geology and physiography, or of the "origin and development of topographic forms," to enable him to appreciate the features which he is sketching and to represent them intelligently on his sketch.

Mr. Wilson's book is, however, very far from being a simple manual for the use of the Geological Survey. It deals with every description of survey, and treats each fully. Part i. contains much useful information on the different classes of survey. An interesting description is given of the survey of Baltimore on a scale of 1/2400, which corresponds nearly to the 25-inch scale of the Ordnance Survey; but if the figures given in the table, p. 107 (Baltimore 814*l.* per square mile, Ordnance Survey 59*l.*), are correct, the cost would be considered prohibitive in this country. The remarks on geographic and exploratory surveys are good, and Mr. Johnson's excellent plane-table sketch, which is given as a specimen of an exploratory survey (p. 91), may well serve as a model for sketchers. Military surveys are correctly defined as having for their object "the representation of the natural and artificial features of the country with the maximum exactitude consistent with the greatest rapidity of execution." The concluding chapter is a well illustrated memoir on the relations of geology to topography, and on 'earth sculpture,' or the constructive and destructive processes by which existing topographical features have been formed. The importance of a knowledge of these subjects to the topographer and cartographer is clearly pointed out. A valuable addition to the chapter is a glossary of all geographical and topographical descriptive terms in common use in the United States, which, pending the compilation of a similar list for the United Kingdom, will be found useful in this country.

In Part ii. the instruments and methods employed in the measurement of horizontal distances and in plane surveying are clearly described and explained. Chapters vii. and viii. on plane-tables and alidades, and chapters xii. and xiii. on stadia and angular tachymetry, deserve the attention of surveyors in England, where stadia measurements, which give results over rough ground as good as those with the chain, are little known. In another chapter the author describes photo-surveying methods, which are much in favour in Canada, and points out their limitations and the conditions under which they can be advantageously employed. Part iii. deals with instruments and methods for the determination of altitudes. The American spirit levels and levelling staves are of better pattern than those in use on our Ordnance Survey, and the accuracy of the principal lines of levels is greater than that of the similar lines in Great Britain. In Part iv. the author explains the various kinds of map projections, the methods of representing hill features and the construction of relief maps. He very rightly lays down that the cartographer should be "possessed of such actual knowledge of map-making as is only gained by practical experience in field-surveying," and that the topographer should have a general knowledge of projections and map construction. The difference between the principal methods of representing ground is well brought out; that by hachures is happily characterised as "a graphic system with a conventional element," and that by contours at close intervals as "a conventional system with a graphic element." Wax and clay mixed with glycerine are considered the best materials for modelling, and it is pointed out that a modeller should have a good knowledge of topography. Parts v. and vi., "Terrestrial Geodesy" and "Geodetic Astronomy," are clearly written and well supplied with tables; and the latter contains a chapter on "Photographic Longitudes." In Part vii. the surveyor in unsettled country will find many excellent hints as to camp stores and equipment, pack transport, medicines, clothing and photography.

In conclusion, it may be added that the book contains 884 pages, 62 tables of various kinds, 205 excellent illustrations, and a most useful index. It would in some respects have been more convenient if it had been published in two volumes. C. W. W.

THE ETHNOGRAPHY OF BRITISH COLUMBIA.

Memoirs of the American Museum of Natural History. Vol. II. *Anthropology.* i. *The Jesup North Pacific Expedition.* iv. *The Thompson Indians of British Columbia.* By James Teit. Edited by Franz Boas. (1900.)

IMPORTANT results were looked for from the Jesup North Pacific Expedition, and the realisation has not belied the expectation. Thanks to the intimate knowledge of Mr. James Teit of their language, customs and beliefs, we now have a remarkably detailed and complete description of the Upper and Lower Thompson

Indians, especially as this is supplemented by the valuable work done by Dr. G. M. Dawson, Dr. Franz Boas, Mr. C. Hill Tout, and others on these or allied tribes of British Columbia, under the auspices of the British Association for the Advancement of Science.

The Upper Thompson Indians live in the valley of the Thompson River, while the Lower Thompson Indians dwell on the Fraser River. They appear to have decreased to one-third since the advent of the white man in 1858. The birth-rate is about equal to the deaths, but there is great mortality among young children; at the present time the population in some places seems to be about stationary, or is slowly increasing. The Lower Thompson Indians are quieter and steadier than the people of the upper division, but are slower and less energetic; they are also better fishermen and more expert in handling canoes, while the Upper Thompson Indians are better horsemen.

In this copiously-illustrated memoir Mr. Teit has carefully described the handicrafts of the Thompson Indians. Most of their implements were made of stone, bone, wood, bark, skins, matting or basketry. Work in stone, bone and wood was done by the men, while the preparation of skins, matting and basketry work fell to the share of the women. There was a certain amount of division of labour, as workmen skilful in any particular line of work exchanged their manufactures for other commodities.

The various kinds of habitations and clothing and ornaments are fully described, and the changes that have ensued since 1858 are recorded. For example, beads and dyed porcupine quills were largely used for embroidery before that date; but these were soon replaced by embroidery done in silk thread, and most of the patterns wrought at the present day are copies of the white man's patterns. Full accounts are given of the arts, of subsistence, varieties and preparation of food, hunting, fishing and the like, as well as of travel, transportation, trade and warfare.

The games and pastimes of adults and children are carefully dealt with, and this account usefully supplements what has been previously recorded for similar tribes. It is a pity that the author describes as a "bull-roarer" quite another kind of toy, which Culin calls a buzz; the latter is an oblong or circular piece of thin wood, with two holes near the centre through which a string is passed. It is widely distributed among the Indians of North America, and, so far as is known, has little in common with the true bull-roarer. The smaller boys and girls play "cats' cradle," and we are told they make many forms such as the "beaver," "deer," "man stealing wood," &c. Fig. 270 illustrates two of these puzzles, one—"dressing a skin"—is very difficult to follow; the second—"pitching a tent"—is simpler, and, strangely enough, is precisely similar to the "fish-spear" string puzzle of the Torres Straits Islanders.

Very interesting and instructive are the accounts given of the social organisation and festivals of the people, and of the customs relating to birth, childhood, puberty, marriage and death. Their religion is fully dealt with, and it is worthy of note that no totemism is recorded for these people; but each individual has a guardian spirit, which was acquired during the puberty ceremonials. Only a few shamans inherited their guardian spirits without such ceremony from their parents, who had been particularly powerful. The guardian spirits of these parents appeared to them, uncalled for, in dreams and visions. The moral code is excellent, and the young people are often admonished and advised. It is good to be pure, cleanly, honest, truthful, brave, friendly, hospitable, energetic, bold, virtuous, liberal, kind-hearted to friends, diligent, independent, modest, affable, social, charitable, religious or worshipful, warlike, honourable, stout-hearted, grateful, faithful and revengeful to enemies. Various legends are noted, and there are the usual constellation myths; but several of the stars or constellations have not been identified, so that no comparative study is possible. The traditions have been published in full by Mr. Teit in the *Memoirs of the American Folk-lore Society*, vol. iv.

The memoir concludes with a chapter on art and a summary, both by Dr. Boas. The decorative art of the Thompson Indian is very crude; form and decoration have no intimate connection, comparatively few designs are primarily decorative, their fundamental idea being symbolic. For this reason, by far the greater number of designs may be described as pictographs rather than as decorations.

The Thompson Indians are in appearance and culture a plateau tribe, influenced, however, to a great extent by their eastern neighbours, to a less extent by the tribes of the coast. Their whole social organisation is very simple, and the range of their religious ideas and rites is remarkably limited when compared with those of other American tribes. This may be one of the reasons why, in contact with other tribes, the Salish have always proved to be a receptive race, quick to adopt foreign modes of life and thought, and that their own influence has been comparatively small.

If all the field-work done by the numerous investigators on the staff of the Jesup North Pacific Expedition is as complete and workmanlike as the present memoir, and is published in similar first-class style, the result will be a dignified monument to the ability of American anthropologists and to the enlightened munificence of Dr. Jesup.

ALFRED C. HADDON.

OUR BOOK SHELF.

Lubrication and Lubricants. By L. Archbutt and R. M. Deeley. Pp. xxiv + 451. (London: C. Griffin and Co., Ltd., 1900.)

MESSRS. ARCHBUTT AND DEELEY have, in this treatise, placed before engineers and power users what is known of the theory and practise of lubrication.

Until the introduction of mineral oils as lubricants, there was comparatively little difficulty in obtaining good oils; the animal oils, such as sperm and lard, and the vegetable oils, such as castor, will keep a bearing cool, while mineral oils of the same apparent viscosity will allow it to heat. Oil users can only meet this difficulty by subjecting the oil to both chemical and mechanical tests.

The work is divided into two portions: the first treating of the theory of friction and the properties of lubricating substances, while the second describes the forms of bearings. The experiments of Mr. Beaucamp Towers and

Prof. Goodman have greatly added to our knowledge of the friction of bearings, as distinguished from the friction of rest, as found in our academic text-books. Messrs. Archbutt and Deeley have given a clear and extensive account of the modern ideas on friction.

Prof. Osborne Reynolds' monograph on the theory of friction is certainly one of the finest works on the subject, and it is to be regretted that his results are not more generally known to engineers.

The portion of the present volume relating to the chemical and physical examination of oils is thorough and copious; it will be of great service to chemists, but is somewhat beyond the range of most engineers, who, if they test their oils in any way, use the mechanical oil-testing machine, which, while useful in its way, does not give the same knowledge of the properties of a lubricating oil as does the chemical test.

We consider that oil-testing machines are only capable of yielding satisfactory results in the hands of experts, and then only when much time is expended in experiments. For research purposes they are most admirable, and from their use we have obtained practically all we know of friction; but for commercial testing we should prefer to rely on chemical and physical methods. The design and care of bearings are well described in the second part; all forms of bearings, from those of watches and clocks, cycles and large engines, are illustrated. We are pleased to see the block packings for piston rods described; the ordinary gland packing is certainly a defective form, and is the cause of considerable loss of power, even when no serious heating occurs. The omission of the system of forced lubrication seems a pity, especially as Messrs. Belliss and Morcom have applied it with so much success to their well-known quick-revolution engine. The work is, we consider, of the greatest value, and should be in the hands of both designers and users of all forms of machinery in which lubrication is important. F. W. B.

Darwin and Darwinism, Pure and Mixed. By Dr. P. Y. Alexander. Pp. xii + 346. (London: Bale, 1899.)

THE decade which followed the appearance of the "Origin of Species" witnessed the publication of innumerable books and articles dealing with Darwin's great work. Although many of these were solid and valuable contributions to the literature of evolution and natural selection, the mass as a whole was characterised by the large proportion of works which proclaimed with the utmost confidence the opinions of authors unknown as naturalists. Men whose claim to a hearing was of the slenderest kind spoke with contempt of Darwin's reasoning powers or the rashness of his generalisations. After 1870 such works became rarer, and at the present day are, happily, quite uncommon. The book before us is, however, about as bad an example as can be found. It would not have been astonishing in 1869 to be told by a writer unknown as an original observer or thinker that "Mr. Darwin's capacities of thinking and drawing inferences from the immense masses of fact he had collected were not at all equal to his powers of observation, investigation and classification," or to observe the calm satisfaction in the following sentence: "My little effort will show that, wherever I have paid special attention to any department of natural history or natural science, I am apt to find Mr. Darwin at fault, more especially in his generalisations." The mildest statement which can be made about the publication thirty years later of such opinions by a Mr. P. Y. Alexander—author of "Heredity," "Parasitism," &c., notwithstanding—is that the work is an anachronism.

The literary style may be sufficiently exemplified by a couple of quotations from the "Argument of the Book."

"(2) Mr. Darwin went for essential *slowness* as a necessity of nature. He said in 'Origin' 'Nature can never take any great and sudden leaps.' When instances were presented to him of 'sudden leaps,' he tried to gloss it over, and always harked back on *slowness*" (p. ix.).

"(7) Mr. Darwin's notion that 'domestic animals which have long been habituated to a regular and copious supply of food *without* the labour of searching for it are more fertile than the corresponding wild animals,' shown by instance on instance to be *absurd*, opposed to the practice of all great breeders, and is, besides, physiologically impossible" (p. xi.).

It is probable that the reader who looks at such sentences as these will not feel sufficiently encouraged by the manner or matter to penetrate further, even though "the most absolute refutation of poor Darwin's fallacy" should be later on established, to the entire satisfaction of the author. E. B. P.

Electric Wiring Tables. W. P. Maycock. Pp. iv + 144. (London: Whittaker and Co., 1900.)

MR. MAYCOCK'S pocket-book of tables should prove very useful to those electrical engineers whose work consists solely of wiring and fitting. It contains in a very convenient form tables of all the quantities likely to be wanted in such work, and has the advantage of being quite up to date, the values in the tables of the safe currents, resistances, &c., of copper conductors being calculated on the basis of the recommendations of the Institution of Electrical Engineers Committee on Copper Conductors, which only made its report at the beginning of this year. It is, perhaps, a disadvantage of the pocket-book that it is so limited in its scope, and we are inclined to think that it would appeal more strongly to the particular class of electrical engineers for which it is designed if more general information were included. A summary of the fire insurance rules should certainly be inserted, and it would be useful if some idea were given of the approximate costs of wiring on the different systems alluded to in the section on "Systems of Wiring." Some of the tables are simply "Ready Reckoners"; for example, the tables of "Price and Length of Conductors" give the prices of different lengths of conductors calculated from the price per yard, and would apply equally well to wood-casing and metal-piping, a fact which should be indicated in the title of the table. The table giving the current taken by different numbers of lamps working at different pressures and different efficiencies is a very useful one, particularly now that high-efficiency lamps are being brought forward. The same can hardly be said of the list of towns supplying on the alternate current system, since no details are given as to pressure and frequency. The usefulness of the pocket-book would be considerably increased by the addition of an index.

Raggylug, the Cottontail Rabbit; and other Animal Stories. By Ernest Seton-Thompson. Pp. 147. (London: David Nutt, 1900.)

MR. SETON-THOMPSON'S success as a writer about animal life lies in the fact that he endows his subjects with human faculties and sympathies. It is, of course, illogical to make animals consider everything from an anthropomorphic point of view; but, after all, this is the only point of view which it is possible for us to conceive, and there is no objection to occupying it, provided that its artificial nature is borne in mind. By following this method, Mr. Seton-Thompson's animal stories have a sentimental interest, and they create a love of animate nature in the minds of all who read them. There are four stories in the present volume, and each is an instructive as well as interesting narrative of animal life. Children will read the stories with delight, and adults will find their sympathies awakened by them.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Leonids—a Forecast.

IN the *Proceedings* of the Royal Society for March 2, 1899 (vol. lxiv. p. 403), will be found an account of the perturbations suffered since 1866, November 13, by the Leonids which in that month intersected or passed close to the earth's orbit. This position in the meteor stream may be called station A (Fig. 1).

We have since investigated the principal perturbations affecting two other points in the stream, viz., the station Z, which intersected the earth's orbit 360 days earlier, *i.e.* in November

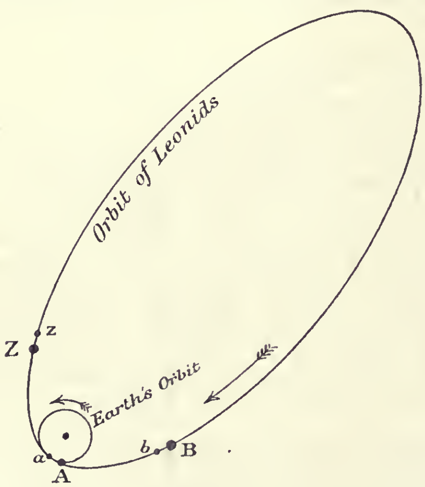

FIG. 1.

1865, and the station B, which intersected the earth's orbit 360 days later, *i.e.* in November 1867.

We therefore now know the principal perturbations which during the last revolution of the meteors have affected three points, Z, A and B, situated along an orbit (Adams's orbit) which, at the commencement of the revolution, lay within the stream.

The full results of the investigation will not be ready for publication till after the time when the Leonid shower of this year is due, and on this account it has been thought expedient

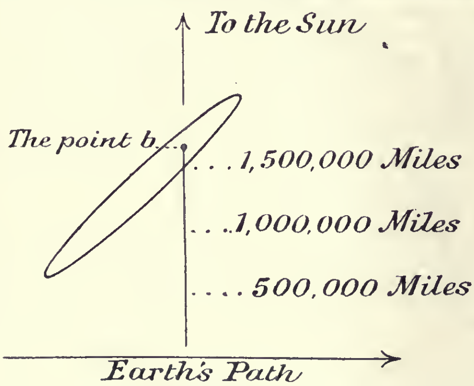

FIG. 2.

to publish beforehand such of the results as have special reference to it.

A point in the stream which in 1867 lay along Adams's orbit between A and B, but nearer B, and which we may call the point *b*, will this year reach its descending node simultaneously with the earth. This will happen approximately on 1900, November, 15d. 3h. Greenwich mean astronomical time.

Unfortunately, the orbit of a meteor situated near point *b* in the stream, instead of intersecting the earth's orbit as it did in 1867, will now pierce the plane of the ecliptic in a point which lies about 0·018 nearer the sun. Now, 0·018 of the earth's mean distance from the sun is 1,674,000 miles; so that, of the meteors which in 1867 intersected the earth's orbit, those which will come nearest to the earth in the present year will not approach it nearer than a million and six hundred thousand miles.

It is known from the duration of the great showers that the width of the ortho-stream, if measured in the direction which is parallel to the earth's path, is only about 300,000 miles; but there is reason to believe that the Leonids entered the solar system under conditions which have made the section of the stream much longer than it is broad, so that its trace upon the plane of the ecliptic is something like what is represented in Fig. 2. The longer axis of this cross section lay originally along the radius vector from the sun, but perturbations have acted on the Leonids for nearly 1800 years of such a kind as have probably caused the section of the stream to incline in the direction represented in the figure.

If the section is long enough to reach the earth's orbit, we shall have a great meteoric shower this year. It is, besides, just possible that a sinuosity in the stream may so displace a part of the section as to bring it sufficiently far out. But neither of these seem likely to have happened; so that the present investigation does not raise any hope of a great shower this year.

If, contrary to our expectation, the axis major of the section proves to be long enough to reach the earth's orbit, the consequent shower of ortho-Leonids is likely to occur several hours—possibly more than a whole day—earlier than

1900, November, 15d. 3h.

The number of hours by which it will precede that epoch depends upon the angle which the axis major of the section makes with the radius vector from the sun—an angle which is at present unknown. If there is this year a shower of ortho-Leonids, the time at which it occurs will enable us to determine this important datum.

Station *a* in the stream (see Fig. 1) intersected the earth's orbit in 1866, but after completing a revolution it passed the earth in November of last year at a distance of some 1,300,000 miles; and *z*, the corresponding point for the preceding year, which also intersected the earth's orbit in 1865, was on its return distant from the earth in November 1898 by about 960,000 miles. It thus appears that the displacements of the meteoric orbits which have been brought about by the perturbations of the last thirty-three years suffice to have prevented the meteoric orbit from now intersecting the earth's orbit. This accounts for our not having had any great shower in either of the last two years, and unfortunately the conditions seem still more unfavourable in the present year.

Nevertheless, as there is always a possibility that one or other of the contingencies mentioned above may carry a part of the ortho-stream out as far as the earth, and as we have no means of ascertaining whether those contingencies have arisen, it is desirable that preparation shall be made for adequately observing the shower, if it should unexpectedly come.

The perturbations during the last revolution, which have for the present carried the ortho-stream of Leonids so far from the earth's orbit, belong to the class of perturbations which act at different times with equal effect in opposite directions; so that there is reasonable ground for expecting that further perturbations must at some future time bring this remarkable stream back to the earth's orbit. It would be possible to ascertain when this will happen, by an investigation carried over a sufficient time forward upon the same lines as those which we have pursued.

G. JOHNSTONE STONEY.
A. M. W. DOWNING.

October 24.

Examinations in Experimental Science.

YOU occasionally do us, who are humble teachers of Elementary Science in schools, the very great kindness of giving us, through your columns, the chance of reaching the ears of those eminent men who are your frequent contributors, and who examine our pupils. Will you, in the interest of that real science teaching, so often advocated in your columns, allow me such a chance now? I will be as brief as possible. In common with a few individuals and many public bodies, I have spent a very large amount of time, money and labour in introducing the teaching of practical physics into my school, and trying to see that it shall be of the best kind possible, and I am prepared to do more.

But really there must be some agreement between us and the said eminent men as to what practical science is when the examination paper is composed.

May I give my illustration? The Cambridge Local Syndicate have introduced Elementary Experimental Science, three papers, into their junior syllabus. The other day I set two of these three papers for 1899 to a number of boys who had had a most careful experimental training in the matter of the syllabus. They made wry faces over it, and were heard to remark afterwards that they did not see what it had to do with the experiments they had been doing. On marking the papers I found that the best boys, really very good and careful experimenters and observers and good draughtsmen, for boys, barely reached forty per cent. of the marks. The same papers were set to a sharp boy of the same age who had done no experiments, but had been through the same subjects, mechanics, hydrostatics, and heat, in the old way, viz., text-book and problems. *He scored nearly full marks on all the physics questions.*

The fact is, that except for the heading, "Experimental Science," there is nothing in two of these papers to indicate that they are set to candidates whose knowledge is based on and drawn from experimental work of their own.

I should like to ask you to print these papers in full, that the eminent men who set them might have a chance of saying something, but on the whole I think your space is too valuable. I will simply quote two questions from the mechanics paper.

"(3) Explain how work is measured, and in what units.

"A 50 lb. shot is fired from a cannon with a velocity of 1500 feet per second. Compare the work done on the shot with that done by a man weighing 12 stone who walks up a hill 1500 feet high.

"(4) What is the mechanical advantage of a machine?

"How would you arrange three separate pulleys, each of which weighs 1 lb., so that the power required to raise a weight of 40 lbs. may be a minimum?

"What arrangement of pulleys is most commonly used in practice? And why?"

Now these are exactly the old Cambridge—"Describe the common pump, &c., questions?" and the way to answer them is to waste no time on experiments, but read your text-book, get up your formulæ and work examples. The second question is of exactly the same type. The other two require a graphical construction, but such as would be readily done by a boy who had used a text-book in which graphic methods were explained.

The first paper is almost equally bad; it is all (chemistry included) text-book science of a very common order. Against the practical paper I have nothing to say.

Now Cambridge men can write excellent elementary text-books on these subjects, witness those of Prof. Glazebrook. Can they not produce among them a paper on Elementary Experimental Science, which shall be what it professes to be, or is the tradition of the common pump still too strong, and the impress of the Mathematical Tripos too indelible?

A. H. F.

Literature of Coffee and Tobacco Planting.

IN the issue of NATURE of August 9 it is stated, in reviewing a book by a French author, that several books on the same subject, *i.e.* coffee—its growth, cultivation and preparation for the market—have already been published in English.

Could you kindly inform me of the names of the publishers or authors of any good works in English on coffee and tobacco growing? I have been, so far, quite unable, out here, to find the names of any publishers of works on tobacco or coffee, and as it is a matter of considerable moment to me to gain the best of information on these subjects, I trust you will see your way to help me.

Salisbury, Rhodesia, South Africa. G. H. JAMES.

[Mr. J. R. Jackson, Keeper of Museums at the Royal Gardens, Kew, to whom we referred our correspondent's inquiry, has kindly sent the following list of books, which may meet the requirements and also be of service to other planters. —Ed. NATURE.]

WORKS ON COFFEE AND TOBACCO PLANTING.

"The Coffee Planter of Ceylon," by William Sabonadière. Published by E. and F. N. Spon, 125, Strand. (1870.)

"Coffee Planting in Southern India and Ceylon," by E. C. P. Hull. E. and F. N. Spon. (1877.)

Article on coffee in "Spon's Encyclopædia of the Industrial Arts, Manufactures and Commercial Products." E. and F. N. Spon.

"Liberian Coffee in Ceylon." From the *Ceylon Observer*. Published at Colombo by A. M. and F. Ferguson. (1878.)

"All About Tobacco." Compiled by A. M. and F. Ferguson, Colombo, Ceylon. Agents, John Haddon and Co., Bouverie Street, London.

Article on tobacco in "Spon's Encyclopædia of the Industrial Arts, Manufactures and Commercial Products." E. and F. N. Spon.

Autotomic Curves.

IN NATURE, October 11, Mr. A. B. Basset justly inveighs against the use of the term "non-singular curve" to denote a curve which has no double points. Doubtless, also, the expression "an anautotomic curve" is objectionable.

May I suggest that, in this instance, we may obtain from Latin the help unknown to Greek, and designate curves which have, and curves which have not, double points, by the terms *sesecting* and *non-sesecting* respectively?

H. LANGHORNE ORCHARD.

44 Denning Road, Hampstead, N.W., October 20.

IN answer to your correspondent, Mr. A. B. Basset, would not the Anglo-Saxon negative prefix "un" combine more euphoniously with "autotomic" than the Greek "an"? We find analogy for such a combination in the familiar words "unauthorised" and "unauthenticated," where it is used in conjunction with words of Latin origin; so there seems no valid philological objection to its association with a Greek derivative, while the phrase "an unautotomic curve" would certainly sound more pleasantly to the ear than "an anautotomic" one.

ARTHUR S. THORN.

4, Malcolm Road, Penge, S.E., October 25.

THE PRESENT CONDITION OF THE INDIGO INDUSTRY.

OF late years attention has often been drawn to German Technical Chemistry, more especially in connection with the advance and growth of the coal-tar colour industry, an industry which received its birth in this country, but which has now taken up its abode on the continent, the loss of the industry to this country being largely due to the conservatism of our manufacturers, and also partly to the want of proper scientific training on the part of the few chemists whom the manufacturers have *deigned* to employ.[1]

Before 1870 the madder plant was very largely cultivated, in order to obtain from it the important dye-stuff alizarin. But in 1869 a process for obtaining alizarin, by fusing anthraquinone sulphonic acid with caustic soda, was patented simultaneously in this country and in Germany. As a consequence the madder plant is now hardly cultivated at all.[2] Now, thirty years later, another and perhaps even more important natural dye-stuff is in jeopardy owing to the advances of German science. The dye-stuff referred to is indigo, which is cultivated in such large quantities in our Indian Empire. If, then, the natural indigo is to be driven out of the market by the artificial substance, prepared from coal-tar products, it cannot fail to exert a great temporary, if not permanent, influence upon the wealth of India. Perhaps, then, a

[1] In the hand-book for the International Exhibition of 1862 (vol. i. p. 120), the following sentences occur: "It is impossible to overrate the importance of the coal-tar dyes to this country. From having the sources of the raw material in unlimited quantities under our very feet, we are enabled to compete most favourably with continental nations in this respect, and we shall soon become the great colour-exporting country, instead of having, as hitherto, to depend on Holland and other countries for our supply of dye-stuffs."

[2] Madder root contains about 1 per cent. of alizarin, and in 1859–1868 the best qualities of Turkey roots fetched 50*s*. per cwt.; this would make the price of alizarin about 45*s*. per lb. When artificial alizarin was first produced, the dry product fetched about 45*s*. to 50*s*. per lb. A 20 per cent. paste of alizarin is now sold for 7*d*. per lb.

brief survey of the processes employed for producing the natural and artificial indigo may be of interest.

Indigo is one of the oldest dye-stuffs known, having been used in India and Egypt before the Christian era. Egyptian mummies are sometimes found with wrappings which have been dyed with indigo. The ancient Romans and Greeks were also familiar with this dye-stuff. Pliny the Younger mentions indigo in his writings, and in this connection it is interesting to note that adulteration of commercial articles was even practised in his days, for he states that indigo was at times adulterated with the excrement of pigeons and with chalk coloured with woad, but he says the pure article may be known by its burning with a purple flame when heated. Indigo was not introduced into Europe until the sixteenth century, and even then, owing to the strong opposition of the woad cultivators,[1] it was a long time before it came into general use. Indeed, so strong was the opposition and so great was the influence of the woad cultivators, that the employment of indigo was prohibited in England, France and Germany, its use in France being in the time of Henry IV. punished by death, it being called "Devil's Food." However, notwithstanding this powerful opposition, the employment of indigo as a dye gradually gained ground until to-day woad is scarcely cultivated and is no longer employed as a colouring matter, but is used in a certain process of indigo dyeing to cause fermentation and reduce the insoluble indigo blue into soluble indigo white.

The indigo plant (*Indigofera tinctoria*) belongs to the natural order Leguminosæ. It is obtained chiefly from India, especially from the provinces of Bengal, Madras and Oude. But it is also grown in some parts of Africa, in Java, China, Japan, Central America and Brazil. The land is ploughed in October or November, and the seed sown at the end of March or the beginning of April. The growth is very rapid, and the plant attains a height of about three feet. It is cut for the first time between the middle of June and the beginning of July. Two months later a second crop is taken, but the yield is smaller than that of the first crop. The land on which the indigo is cultivated is frequently very poor, and contains very little nitrogen, yet indigo is grown on the same land from year to year with only very occasional change of cropping, and this in spite of the fact that practically the only manure employed is *seet*, *i.e.* the indigo refuse, leaves, stalks, &c., which have been taken from the steeping vats. Notwithstanding, the crops obtained from year to year do not show much deterioration either in yield or quality. Dr. D. A. Voelcker, in his report on Indian agriculture, suggests that since indigo belongs to the order Leguminosæ, and it has been shown that certain legumes are able to absorb atmospheric nitrogen through the medium of *nodules* which form on the rootlets, that perhaps the indigo plant obtains the nitrogen it requires in this manner. The writer of this article is, however, not aware whether the subject has been investigated.

The dye indigo does not occur ready formed in the plant, but exists in the form of a glucoside called indican. This glucoside was isolated by Schunk. It is a brown, transparent, uncrystallisable syrup, which, by the action of dilute acids, is split up into indigotin (the colouring matter of indigo) and a sugar called indiglucin. A reaction similar to this is supposed to take place during the fermentation process in the production of natural indigo.

Manufacture.

The cut plant is tied into bundles, which are then packed into the fermenting vats and covered with clear fresh water. The vats, which are usually made of brick lined with cement, have an area of about 400 square feet and are 3 feet deep, are arranged in two rows, the tops of the bottom or "beating vats" being generally on a level with the bottoms of the fermenting vats. The indigo plant is allowed to steep till the rapid fermentation, which quickly sets in, has almost ceased, the time required being from 10–15 hours. The liquor, which varies from a pale straw colour to a golden-yellow, is then run into the beaters, where it is agitated either by men entering the vats and beating with oars, or by machinery. The colour of the liquid becomes green, then blue, and, finally, the indigo separates out as flakes, and is precipitated to the bottom of the vats. The indigo is allowed to thoroughly settle, when the supernatant liquid is drawn off. The pulpy mass of indigo is then boiled with water for some hours to remove impurities, filtered through thick woollen or coarse canvas bags, then pressed to remove as much of the moisture as possible, after which it is cut into cubes and finally air-dried.

Another method is to treat the plant with dilute ammonia or alkalis. This method is said to more completely decompose the indican, and thus to give a larger yield of indigo.

The value of indigo as a dye-stuff depends upon the quantity of indigotin which it contains. The percentage of indigotin in the natural indigo varies from 20–90 per cent. Beside indigotin, natural indigo also contains small and varying quantities of indigo red, indigo brown and indigo gluten. The following is an analysis of a good sample of Bengal indigo :—

Indigo blue	61·4 per cent.
Indigo red	7·2 ,,
Indigo brown	4·6 ,,
Indigo gluten	1·5 ,,
Mineral matter	19·6 ,,
Water	5·7 ,,

Artificial Indigo.

After many years of careful and laborious *scientific* work, artificial indigo is beginning to compete with natural indigo, and there seems to be but little doubt that, unless the producers of the natural article are able to improve the process of manufacture, in the near future the artificial product will, in all probability, get the upper hand in the struggle. Engler and Emmerling appear to have been the first chemists to obtain artificial indigo. They obtained it by the action of zinc dust and soda lime upon ortho-nitroacetophenon, but the quantity obtained was very minute, and, as the mechanism of the reaction was not at that time understood, it did not much help in paving the way for further research work. For most of our present knowledge of indigo we have to thank von Baeyer, whose work on indigo may be looked upon as one of the chemical triumphs of the century. So far back as 1868, von Baeyer obtained indol directly from indigo, and, in the following year, in conjunction with Emmerling, he prepared this substance by fusing crude nitrocinnamic acid with caustic potash and iron filings ; shortly afterwards they discovered that by the action of phosphorus trichloride, phosphorus and acetylchloride on isatin, a product was obtained, which, when exposed in aqueous solution to the action of the air, gradually deposited indigo ; this method was subsequently improved. In 1875 Nencki obtained indigo by the oxidation of indol with ozone. But it was not till the year 1880 that any great progress was made in the synthesis of indigo. In this year von Baeyer published a series of brilliant researches showing how indigo could be obtained from ortho-nitrocinnamic acid. He showed that when ortho-nitrocinnamic acid is subjected to the action of bromine, ortho-nitrodibromcinnamic acid is obtained, which when treated with alkalis in the cold is converted into ortho-nitrophenylpropiolic acid, and this substance, on being warmed with a dilute solution of caustic soda and grape sugar, or some other alkaline reducing agent, is converted into indigo, the yield compared with

[1] The colouring matter of woad, *Isatis tinctoria*, is indigo.

that theoretically possible being 70 per cent. Von Baeyer also showed that, by acting upon ortho-nitro-cinnamic acid with caustic soda and chlorine, ortho-nitro-phenylchlorolactic acid was produced, which on treatment with alcoholic caustic potash was converted into ortho-nitrophenyloxyacrylic acid, and this on being fused yields small quantities of indigo. Owing, however, to the high cost of ortho-nitrocinnamic acid, indigo so produced could not enter into competition with the natural dye. In 1882 von Baeyer and Drewson brought out yet another synthesis. They found that, by acting upon a mixture of ortho-nitrobenzaldehyde and acetone with caustic soda, indigo was produced, and, further, if the starting products were pure, that the yield of indigo was 80 per cent. of that theoretically obtainable. In 1890 Heumann discovered that when phenyl glycine was melted with caustic soda, taking care that air was, so far as possible, excluded, a yellow-coloured fuse was obtained. This fuse, on being dissolved in water and exposed to the action of the air, produced indigo.

Unfortunately, although the low price of the materials employed should have caused this to be a successful manufacturing process, the yield of the dye-stuff was very poor. Heumann shortly afterwards showed that a very much better yield could be obtained by employing phenylglycine-ortho-carboxylic acid, but although the yield was better the cost of production was higher, the more expensive anthranilic acid taking the place of the cheaper aniline as a starting product. Of late, however, the price of anthranilic acid, owing to improved methods of manufacture, has fallen very considerably, and, doubtless, will continue to fall. Indigo can also be obtained by fusing bromacetanilid with caustic potash, the indol so produced being oxidised by the action of the air to indigo. Again, when ortho-nitroacetophenone is carefully heated with zinc dust, a sublimate of indigo blue is obtained. There are many other syntheses of indigo known, but the majority of them are of more theoretical than practical importance.

Of the many methods for obtaining artificial indigo, only two or three modifications are employed for manufacturing the dye. These are von Baeyer's ortho-nitro-benzaldehyde and aceton synthesis, and that of Heumann from o-phenylglycinecarboxylic acid. But beside indigo itself there is a substance sold under the name of "indigo salt," which is the sodium bisulphite salt of the methylketone of o-nitrophenyl-lactic acid. It is readily soluble and is used for indigo printing.

Artificial indigo as brought into the market contains over 90 per cent. of indigotin, whereas in the natural product the quantity varies from 20 to 90 per cent. The artificial product, however, contains no indigo-red, indigo-brown, or indigo-gluten; whereas these substances are present in natural indigo, and exert an influence in dyeing certain shades of indigo. Indigo itself cannot be employed for dyeing owing to its insolubility. But when subjected to the action of reducing agents it is converted into *indigo-white*, which is soluble in alkalis. Wool or cotton dipped into such a vat and then exposed to the action of the air become dyed a fast blue.

One would have supposed that the indigo producers would have taken warning from the extinction of the artificial alizarin industry, and called to their aid experienced agriculturists to see if it were not possible to increase the yield and quality of the indigo plant, and chemical experts to endeavour to improve the process of manufacture. This, however, has not been done. The planter appears uncertain whether thick or thin seeding is the better, whether any other manure except *seet* should be employed. Again, whether the *seet* should be applied to the land fresh or whether it should first be allowed to ferment. The manufacturing is entirely conducted by "rule of thumb." It is a matter of dispute as to whether the bundles of indigo plant should be packed tightly or loosely in the vats. If the water employed should be hard or soft is purely a matter of individual opinion. Again, it is a question of debate as to how long the cut plant should be steeped, &c. The Badische Anilin Soda Fabrik is said to have invested 500,000*l.* in plant for the manufacture of artificial indigo. Will British (Indian) manufacturers never lay out capital in scientific investigation? Will they *never* realise that money so laid out is almost certain in the near future to bring in a rich return? In conclusion, I give the following quotation from the report on the trade of Frankfurt for 1899, by Consul-General Sir Charles Oppenheimer:—

"In the territories in which natural indigo is grown, the intensity and magnitude of the danger which lies in the advance of the artificial product ought not for a moment to be disregarded. The struggle between artificial and natural indigo has already commenced. The latter still shows some advantages, inasmuch as its bye-products, such as indigo gluten, indigo red, &c., aid the dyeing process to some extent. If natural indigo is to retain its position, every effort must be directed in a rational manner to organising its culture towards the manner in which it is collected, and the way the dye is shipped. In order to obtain a favourable result, the ablest experts should co-operate in this important task. To-day the fate of East Indian indigo culture lies unfortunately in the retorts of the chemical factories."

F. MOLLWO PERKIN.

THE FORM AND SIZE OF BACTERIA.

BACTERIA is a generic term that has been applied to an extensive group of single-celled organisms belonging to the lowest forms of plant life The bacteria obtain their nutriment from organic matter, either dead or living, and are therefore capable of leading a saprophytic or a parasitic existence. They are amongst the smallest forms of life with which the biologist has to deal, the transverse diameter of the individual cells seldom exceeding a few micro-millimetres, or it may be a fraction of a micro-millimetre. The highest powers of the microscope are consequently necessary for the study of their structure, which is of a simple character, consisting essentially of protoplasm with a containing cell-membrane. The most striking differences are to be found rather in the biological properties of the bacteria as promoters of decomposition, putrefaction and fermentation, or as the originators of morbid processes in plants and animals, than in any distinctive features they possess as vegetable cells. The following account is simply intended to give the reader who is not a specialist a general conception of the main types of these organisms, which form the special study of bacteriology.

It may, in the first instance, be pointed out that though the bacteria are microscopically minute organisms, yet considerable variations in shape and size occur. The illustrations in the accompanying plate have been selected to illustrate these two points. It will be seen that, for example, amongst the most widely known pathogenic organisms the variation in form is considerable, whilst in point of size the largest of these is many times greater than the smallest. Bacteriology is at present largely dependent for a classification of the bacteria upon the variations that occur in their shape. The individual cells multiply by a process of fission, and the fundamental forms are spherical, oval, rodlike or spiral in shape. At the same time the species cannot be entirely determined by the microscopic appearance. In fact, there are many organisms which it is impossible to identify until other characteristics, such as the macroscopic appearance of their artificial growth on suitable media, or their pathogenic effects on animals, have been observed. The fact has also to be remembered that a

particular organism may under different conditions assume changes in shape, and that even under apparently the same conditions variations in shape and size may occur.

The organisms of a spherical shape are termed Cocci, the individual cells appearing as spheres, except during the period of fission, when elongated or lance-shaped forms occur—e.g. *Diplococcus pneumoniae.* The mode of cell-division determines the nomenclature applied to the various classes of cocci—those dividing in one direction and remaining attached in pairs or chains are termed diplo- or strepto-cocci; those dividing in two directions and forming groups of four—tetracocci; those dividing in three directions and forming packets—sarcinæ; and those dividing irregularly into grape-like clusters—staphylococci.

The standard of measurement for bacteria is the *mikron*, equal to 1/1000 part of a millimetre, and represented by the sign μ. The diameter of the cocci varies from about $0{\cdot}3$ to 3μ.

The organisms in which the length is always greater than the breadth are termed bacilli. Their shape is cylindrical, and they assume a rod-like form; of the most important forms the length may vary from $0{\cdot}5\mu$ to $3{\cdot}5\mu$, and the breadth from $0{\cdot}5$ to $0{\cdot}8\mu$. The bacilli may occur isolated, in pairs, or in chains.

The third main group, the spirilla, are spiral in shape, or more accurately their form represents the fraction of the thread of a screw. The spirilla, like the bacilli, divide in one direction, and may occur as comma, S-shaped or corkscrew forms. The cholera organism has a diameter of about $0{\cdot}4\mu$.

The transverse diameter is usually taken as the standard of measurement, as it is more constant than the long diameter of the bacteria.

The dimensions of the organisms shown in the accompanying illustrations are as follows:—*Streptococcus pyogenes*, $0{\cdot}6$–$0{\cdot}8\mu$; *Staphylococcus pyogenes aureus*, $0{\cdot}7$–1μ; *Diplococcus pneumoniae*, $0{\cdot}5$–$0{\cdot}8\mu$; *Bacillus pestis*, B. $0{\cdot}6\mu$, L. $0{\cdot}6-1{\cdot}9\mu$; *Spirillum cholerae*, B. $0{\cdot}4$–$0{\cdot}6\mu$, L. $0{\cdot}8$–2μ; *Bacillus typhosus*, B. $0{\cdot}6$–$0{\cdot}8\mu$, L. 1–$3{\cdot}2\mu$; *Bacillus tetani*, B. $0{\cdot}5\mu$, L. $1{\cdot}2$–$3{\cdot}6\mu$.

The example seen in Fig. 1 is the *Streptococcus pyogenes*, which is responsible for various septic processes in man. The grouping into chains is a characteristic feature of this organism. There is little variation in size of the individual members of the chain, with the exception of detached or isolated cells, which may be double the size of the normal cocci, *e.g.* when cell-division occurs. Micrococci are not generally subject to such individual variations as bacilli, as can be seen in Fig. 2, *Staphylococcus pyogenes aureus*, where only slight variations in size are to be detected. In Fig. 3 is an example of a very pleomorphic organism, the plague bacillus. It is ordinarily a very short, thick rod, almost appearing as a diplococcus when subdivision occurs. In the photograph, one rod is seen which is about six times the size of the others, and this is by no means uncommon. In a fluid culture the form of the plague bacillus is entirely altered, the organism almost assuming the appearance of Fig. 1. The *Micrococcus pneumoniae* (Fig. 4) is one of the most variable of the diplococci, the individuals in a pair being rarely equal in size, and sometimes elongated, as seen in the photograph. The cholera organism (Fig. 5) is inconstant in size, and its chief characteristic is the bent rod or comma shape. The tetanus bacillus (Fig. 6) is of large size in relation to the other organisms noticed. It is usually a straight rod, except when spore-formation occurs, when it assumes the drum-stick appearance, as seen in the photograph. The typhoid bacillus (Figs. 7 and 8) is very variable in size, although its rod-like shape is constant. The organisms generally have been stained with gentian violet, except in Fig. 8, where Van Ermengem's method for demonstrating flagella has been adopted. This process is not a true staining method, it is really a deposit of a silver-salt on the organism and its flagella. The organism appears much larger than when stained in the ordinary way. Many organisms are like the typhoid bacillus, endowed with flagella, which are probably exclusively organs of locomotion. In Fig. 8 they surround the bacillus, and are many times longer than the organism itself. In other organisms one finds sometimes unipolar or bi-polar flagella.

The illustrations accompanying this article have been produced in the photographic laboratory of the Jenner Institute of Preventive Medicine. The magnification is in all cases 1750 diameters, this being regarded as the highest at which satisfactory photographs of bacteria can be taken, a higher magnification generally resulting in the outline of the organism becoming blurred. The objectives used were a Zeiss 3 mm. apochromatic and a Winkel $1{\cdot}8$ mm. fluorite system, low-power projection oculars being used in each case, and magnification obtained by suitable camera extension. The organisms were all stained, so that a yellow screen was necessary when photographing. The screen used was a saturated solution of acridine yellow, about 15 mm. thick, and with this uniformly satisfactory results have been obtained.

ALLAN MACFADYEN.
J. E. BARNARD.

NOTES.

THE 101st anniversary of the death of Domenico Cirillo, friend of Linnæus, and famous both as botanist and physician, occurred on Monday, October 29. The account of the life and work of this great Neapolitan, given by Prof. Giglioli in another part of the present issue, appears, therefore, at a very appropriate time, and will be read with much interest by every naturalist. We are glad to be able to publish this appreciative notice of some of Cirillo's contributions to science, and thus to add to the number of those who, knowing his works and career, will cherish his memory.

THE announcement of the death of Prof. Max Müller, at Oxford on Sunday last, has been received with universal regret. The funeral has been arranged to take place to-day at Holywell Cemetery, Oxford.

ACCORDING to a *Times* report from Constantinople, "An Imperial Iradé prohibits star-worship and Sabianism in Turkey." It would be interesting to know more exactly what has been prohibited.

THE new science laboratories at King's College were opened by Lord Lister on Tuesday afternoon.

THE death is announced of Mr. William Anderson, professor of anatomy to the Royal Academy of Arts, and the author of a number of works on surgery and anatomy.

A COURSE of Cantor lectures by Prof. J. A. Fleming, F.R.S., on "Electric Oscillations and Electric Waves," will be delivered on Monday evenings in November and December at the Society of Arts.

A DESTRUCTIVE series of earthquake shocks occurred at Caracas, the capital of Venezuela, and the surrounding districts on Tuesday, October 30. The town of Guaronas has been entirely destroyed.

A VISIT to the Chelsea Physic Garden is enough to convince any one of the urgent need of new greenhouses to replace the dilapidated structures in which the existing collections are housed. A more ruinous building than the central range it would be

difficult to imagine, and unless new accommodation be speedily provided for its inmates, the winter's mortality amongst them must be very great. We understand that plans for the erection of new planthouses have for some time been under consideration, and it is much to be hoped that they may be followed by tangible results with as little delay as possible. Under the new *régime*, the garden, with its increased resources, is proving of great use to institutions in which botany forms part of the curriculum, and it would be a great pity if, owing to avoidable damage, its growing utility should be impaired.

IT is stated in the *Bulletin* of the American Mathematical Society that the Steiner prizes of six thousand marks, which were not awarded, owing to no papers being presented, have been divided into three parts which have been given to Prof. Karl Friedrich Geiser, Zurich, for his researches in geometry and his services in the publication of Steiner's lectures; to Prof. David Hilbert, Göttingen, for his researches on the axioms of geometry and for the advancement which analytic geometry has experienced from his work on the theory of of invariants, and to Prof. Ferdinand Lindemann, Munich, who has earned special distinction in geometry by his celebrated discussion of the quadrature of the circle, as well as by editing Clebsch's "Vorlesungen über Geometrie."

THE Senate of New York University has (says *Science*) received and confirmed the votes of its judges selecting thirty eminent native-born Americans whose names are to be inscribed in the "Hall of Fame," now in course of construction on University Heights, New York City. The Americans selected as the most eminent are distributed as follows: Rulers and statesmen, 7; authors, 4; inventors, 4; preachers and theologians, 3; judges and lawyers, 3; soldiers and sailors, 3; men of science, 2; philanthropists, 2; educators, 1; painters, 1. The inventors on this list are Fulton, Morse, Whitney and Howe, and the men of science Audubon and Gray. Franklin is of course also included. Of the hundred judges appointed, ninety-seven voted and the votes cast for men of science were as follows: John James Audubon, 67; Asa Gray, 51; Joseph Henry, 44; Matthew Fontaine Maury, 20; Benjamin Thompson, 19; Benjamin Silliman, 16; Benjamin Peirce, 14; Nathaniel Bowditch, 10; Alexander B. Bache, 9; Spencer Baird, 8; Henry Draper, 8; Maria Mitchell, 7; David Rittenhouse, 6. Twenty further names are to be selected in 1902 by the same judges.

REFERENCE has already been made to the medal which the Queensland Branch of the Royal Geographical Society of Australasia has decided to award. From a circular that has reached us, we learn that the medal has been instituted in recognition of Mr. J. P. Thomson's services to the Society, and is to be called "The Thomson Foundation Medal." It will be awarded annually, or at such other times as the Council may approve, to the author of the best original contribution to geographical literature.

IN memory of the late Dr. R. T. Manson, F.G.S., a well-known naturalist and geologist, a large granite boulder has been taken from the bed of the River Tees and placed on a pedestal in the Public Park, Darlington. The stone weighs about twelve tons, and it is admitted to have come originally from Shap, in Westmorland, in the Great Ice Age. It had been deposited 300 yards above Winston Bridge on the shape and limestone bed of the Tees, where the formation is of the carboniferous age.

THE Board of Education have received, through the Foreign Office, copies of the official translation of the statutes and regulations of the Nobel Bequest. It will be remembered that Dr. Nobel left a large sum, the interest on which was to be devoted to prizes to those who in the course of the previous year should have rendered the greatest service to mankind. The amount thus available was to be divided into five equal parts, to be assigned as follows:—(1) To the most important discovery or invention in the domain of the physical sciences; (2) To the most important discovery or improvement in chemistry; (3) To the most important discovery in physiology or medicine; (4) To the most remarkable literary work (l'ouvrage littéraire le plus remarquable dans le sens de l'idéalisme); and (5) To the person who should have rendered the greatest service in the cause of international brotherhood, in the suppression or reduction of standing armies or in the establishment or furtherance of Peace Congresses. The competition was open to the whole world. It has been found necessary to embody the testator's wishes in a somewhat lengthy and complicated body of statutes. The Board of Education are causing copies of the official translation in French) of these statutes to be transmitted to a number of the chief libraries in England and Wales, to the Universities and University Colleges, to a number of learned societies and to the Press. The regulations for the competition (which will, if possible, be held for the first time in 1901) can thus be consulted by persons interested in the matter.

IT is proposed to publish in separate volumes the lectures on the principles of geology, delivered at the Johns Hopkins University, under the George Huntington Memorial Fund; and subscriptions for the volumes are invited by Prof. W. Bullock Clark, Baltimore, Maryland, U.S.A. The lectures have been given by geologists of international reputation, a fund having been provided for that purpose by the generosity of Mrs. Williams, who thus commemorates the name and work of her husband, formerly professor of inorganic geology in the Johns Hopkins University. The lectureship was inaugurated in April, 1897, by Sir Archibald Geikie, who delivered six lectures on "The Founders of Geology," which have already been published by Messrs. Macmillan and Co. A second course was given in April, 1900, by Prof. W. C. Brögger, who delivered two lectures on the principles of a genetic classification of the igneous rocks, followed by five lectures on the late geological history of Scandinavia, as shown by changes of level and climate since the close of the glacial epoch. Other lectures will be delivered from time to time and will be published in a uniform style. The volumes will thus contain authoritative opinions regarding the fundamental facts of geological science.

THE first place in the *Quarterly Review* is given to a descriptive account of malaria and its relation to mosquitoes, in which some of the facts in seven recent volumes and reports dealing with the subject are considered. To any one who has not had before him the statistics as to the number of deaths from malaria, the mortality from the disease is astonishing. It has been said that one half the mortality of the human race is due to malaria, and though this may very well be an exaggeration, the figures given in the review show the deadly character of the disease and the vast extent of its field of activity. Apart from the mortality, it is stated that the disease probably levies a heavier tribute in the capacity of the officers and officials who administer the British Empire than does any other single agency. Laveran's discovery, in 1880, of the small organism responsible for the disease is, therefore, worthy of greater glory than the victories of any general or the triumph of any political party, for it has greater influence upon human affairs. Lankester had previously described a parasitic organism living in the blood-cells of a frog, and these purely scientific observations laid the foundation for the mosquito-malaric theory propounded by Dr. Manson, and established by the brilliant researches of Ross, Grassi, Bastianelli, Bignami and others. The whole story is told in the review, and it affords another instance of the far-reaching value of scientific work which at the commencement appears to have no practical applications.

In the Geological Series, Vol. i., No. 7, of the Field Columbian Museum publications, Dr. O. C. Farrington describes some new mineral occurrences in America. These include, amongst others, the rare inesite from a mine near Villa Corona, Mexico, a mineral which is only known from three other localities in the world; also some curious crystals of golden calcite from the Bad Lands region, which exhibit such distortion as to have an apparent prismatic form. There is an interesting note also on the use of dolomite as money by the Pomo Indians, inhabiting Lake County, California. The dolomite money is fashioned by cutting symmetrically-shaped cylindrical pieces from the rough pebbles. These are afterwards burned to bring out streaks of a reddish colour and are then polished and perforated. It is stated that a well-worked piece is estimated at almost the value of its weight in gold. A second section of this publication deals with some interesting crystal forms of calcite from Joplin, Missouri, which are remarkable "not only for their size, but for their transparency, varied colour and the perfection of their crystal form." The paper is well illustrated.

IN an article on "The Orange River Ground Moraine" (*Trans.* S. African Phil. Soc. vol. xi. part 2, September 1900), Messrs. A. W. Rogers and E. H. L. Schwarz describe the glacial characters of the Prieska conglomerate which occurs beneath the Kimberley shales. In their opinion it is a true till formed by land-ice; numerous striæ are to be found on the boulders, while the rock-surfaces underlying the conglomerate are clearly glaciated. A number of photographic plates support the conclusions of the authors. They remark that the relationship between the Prieska conglomerate and that known as the Dwyka conglomerate is still uncertain. The Dwyka conglomerate forms the base of the Mesozoic group, and has long been regarded as of glacial origin. An important paper on the chemical composition of the soils of the south-western districts of Cape Colony is contributed to the same publication by Mr. Charles F. Juritz.

PROF. W. M. DAVIS announces (*Appalachia*, vol. ix., March 1900) that his doubts as to the ability of ice to erode deep valleys and basins have been dispelled by a study of the valley of the Ticino, towards St. Gotthard. The fact that the side valleys open into the main valley several hundred feet up, indicates that the ice-stream, while deepening the main channel, rose high enough to prevent the small lateral glaciers from exercising much erosive power on their courses. In a second article (*Proc.* Boston Soc. Nat. Hist., vol. xxix., July 1900) Prof. Davis pursues the subject of "Over-deepened main valleys and hanging lateral valleys," and deals also with the excavation of lake-basins by ice-action.

THE well-known formula for the velocity of propagation of capillary waves or "ripples" shows that the surface-tension of a liquid can be determined experimentally by observing the wave-length and velocity, or the wave-length and frequency of such waves. Dr. Leo Grunmach, of Berlin, has successfully applied this method to liquids, and he now communicates to the *Sitzungsberichte* of the Berlin Academy an account of determinations of the capillary constants of liquefied gases by the same method. The waves are excited by a tuning-fork with needle points dipping into the liquid, and the interference-curves enable the wave-lengths to be measured with considerable accuracy. The method has been applied to liquefied sulphurous acid, Pictet's fluid (a mixture of 64 parts by weight of sulphurous acid with 44 parts carbonic acid), liquefied ammonia and liquefied chlorine, and the values of the capillary constants will, it is surmised, lead to interesting results in connection with critical point investigations.

THE smallest lateral difference of place that is just visible has, until recently, been given as about 50″ to 1′ angular measure. The method employed by Helmholtz and others in reaching this result was the well-known one of bringing two parallel lines together until they finally are just distinguished as two. Prof. George M. Stratton, writing in the *Psychological Review* for September, describes a different method by which it is now evident that a lateral difference of place of about 7″ of arc can be directly perceived. Instead of using lines or points side by side, the experiments which gave this result were made with lines end to end, so arranged that the upper of two perpendiculars could be moved at will to the right or left, while still remaining exactly parallel to the lower line. The observer had simply to judge whether the upper line was continuous with the lower or to which side it was displaced. The results, which gave 7″ as the threshold of space distinction under these conditions, are interesting, as explaining Bourdon's experiments, according to which a difference of position amounting to but 5″ gives a perceptible stereoscopic effect.

MR. FRANK B. WILLIAMS contributes to the *Proceedings* of the American Academy of Arts and Sciences a paper on the geometry on ruled quartic surfaces. Of the quartic scrolls Cremona enumerates twelve, while Cayley divides these scrolls into ten species, stating that Cremona's two remaining species, though properly considered as distinct from the others, may be regarded as sub-forms of his seventh and ninth species. These two are the developable quartic or torse, whose edge of regression is a twisted cubic, and the quartic cones. It is the purpose of Mr. Williams's paper to consider the classification of curves on all ruled quartic surfaces, to find the formula for the number of intersections of any two curves that lie on the same ruled quartic surface, and to point out some of the most notable results obtained in the course of the investigation. The equations of many of the ruled quartic surfaces are so complicated that very serious difficulties arise when we attempt to treat them analytically, and the author finds it convenient to employ the synthetic method of Prof. Story.

MR. F. J. ROGERS, in the August number of the *Physical Review*, advocates the use of the M.K.S., or metre-kilogram-second, system of units in solving problems in mechanics where solutions involving the C.G.S. units of force and work lead to enormously large numerical measures. The author remarks that the common mode of abbreviating these large numbers by using powers of ten gives some trouble to beginners. Mr. Rogers suggests that the corresponding absolute unit of force may be called the large dyne, or the *Dyne* spelt with a big D; but this nomenclature seems capable of improvement in order to avoid confusion with the megadyne, which contains ten of his large dynes.

A SERIES of interesting experiments on the explosive effects of the modern infantry bullet have been carried out in Germany by C. Cranz and K. R. Koch. They used a new Mauser rifle of 6 mm. bore, having a muzzle velocity 100 m. greater than "Model 88." To imitate the effect upon large blood-vessels, while at the same time obtaining simple physical conditions, the experimenters constructed short hollow tin cylinders filled with water, and closed at one end with a sheet of rubber, and at the other with a sheet of parchment paper. Electrodes were mounted before or behind the cylinders, or inside them, and the discharge spark produced by the bullet was utilised to obtain a photograph of its silhouette at various points of its path. Among the important facts thus elicited it appears that the body struck is not displaced by the entry of the bullet. On leaving the body, the bullet carries away with it a small part of the hind surface, having a small round perforation through which the bullet passed. The "explosion" does not take place until the bullet has left the body. After discussing the evaporation, hydraulic-pressure, rotation, and sound-wave theories of the explosion, and discarding them all, the authors conclude that

the apparent explosion is due to the transfer of kinetic energy to the portions hit at later stages, which are thus torn away from those first encountered.

WE have received from Dr. W. Doberck a copy of the observations made at the Hong Kong Observatory during the year 1899, containing hourly values and results of the principal meteorological elements. The volume is the sixteenth of this important series, and the observations are enhanced in value by the fact of their publication on a uniform plan, which admits of comparison of the means of one year with those of another. The weather forecasts show a high degree of success; following the method of analysis usually adopted, and adding together the sum of total and partial success, the percentage amounts to 94. The collection of observations made in the eastern seas and their collation in one-degree squares, for the construction of trustworthy pilot charts, are actively carried on, and these observations are supplemented by registers kept at forty stations on shore. Astronomical and magnetic observations are also regularly made, and the results published in the volume above referred to. The time-ball was successfully dropped throughout the year, with only seven cases of failure.

IT was only in 1889 that Dr. Merriam, in the "North American Fauna," published a synopsis of the pocket-gophers of the genus Perognathus; but since that date a host of new species and races have been described. Accordingly, a revision of the group has been found necessary, which has been carried out by Mr. W. H. Osgood in No. 18 of the publication cited, several new forms being added to the already large list.

WE have received parts iii. and vi. of "Papers from the Harriman Alaska Expedition" (*Proc. Washington Academy*, vol. ii.), the former, by Mr. W. E. Ritter and Miss G. R. Crocker, dealing with the multiplication of rays in a 20-rayed starfish and its bilateral symmetry, and the latter, by Miss A. Robertson, treating of the Bryozoa. The most interesting feature in connection with the starfish (*Pycnopodia helianthoides*) is the presumed relation between one of its arms and the so-called larval organ of the embryo. In regard to the Bryozoa, Miss Robertson remarks that many of the Alaskan species are common to Queen Charlotte Islands, Paget Sound and California. The distribution of all the forms found on the western coast of North America is given, several new species being described.

THE first half of Part iv. of vol. xxviii. of the *Morphologisches Jahrbuch* is taken up by the final instalment of Dr. S. Paulli's important memoir on the pneumatic cavities in the mammalian skull. It is concluded that the homology of these cavities can only be determined by means of their relations to the nasal chamber, and that the terms "frontal" and "sphenoidal sinus" have no morphological value. In Monotremes, pneumatic chambers are wanting, and in other groups the capacity of these increases with the bodily size of the species in which they occur. The second half of the same fasciculus contains the commencement of a memoir by Prof. L. Bolk on the anatomy of apes, the gravid uterus of the langur (Semnopithecus) being the first subject for consideration.

DR. A. B. MEYER, the Director of the Dresden Museum, has sent us the first instalment of a work entitled "Ueber Museen des Ostens der Vereinigten Staaten von Nord Amerika; Reisestudien." In the autumn of 1899, Dr. Meyer undertook a journey to the States for the purpose of inspecting the museums and their methods of arrangement and conservancy, and the present issue describes some of the results of his survey. As is well known, Dr. Meyer has paid particular attention to the construction of museum cases and cabinets, and he seems to have been much interested in some of those in use in America. The present part, which is lavishly illustrated, deals with the museums of New York City, Albany and Buffalo. One of the most striking photographs represents the gallery of Mexican antiquities in the American Museum of Natural History, New York.

WE have received "Verhandlungen der Deutschen Zoologischen Gesellschaft auf der zehnten Jahresversammlung zu Graz, den 18, bis 20, April 1900," which contain a number of short papers on zoological subjects chiefly interesting to specialists. We have likewise been favoured with copies of the *Bulletin International de l'Académie des Sciences de Cracovie*, *Comptes rendus*, for May and July 1900. Among other papers, the latter contains a communication, by M. E. Godlewski, on the effects of oxygen on the development of the embryo of the frog; and a second, by M. S. Maziarski, on the structure of the salivary glands. The last-named author has succeeded in modelling these glands on an enlarged scale in wax, and his paper is illustrated by a plate showing some of these models.

THE following lectures will be given at the Royal Victoria Hall, Waterloo Road, during November:—November 6, "Plants of Long Ago," Mr. A. Seward, F.R.S.; November 13, "Flowers from an Insect's Point of View," Prof. J. B. Farmer; November 20, "The Medicinal Wells of Old London," Mr. W. H. Shrubsole; November 27, "Some Unknown Countries north of Tanganyika," Mr. J. E. S. Moore.

THE sixth volume of *The Reliquary and Illustrated Archæologist*, comprising the four quarterly numbers issued this year, has been published by Messrs. Bemrose and Sons. The separate numbers of the magazine have been noticed in these columns as they appeared, but this need not prevent us from remarking that Mr. Romilly Allen, who edits the publication, and his fellow archæologists, are to be congratulated upon the excellent character of the text and illustrations of their organ.

DR. M. C. COOKE's book entitled "One Thousand Objects for the Microscope" is well known to microscopists, and the new edition, which has just been published by Messrs. Frederick Warne and Co., is likely to have an even wider sphere of usefulness. Originally, the book consisted of a list of objects, with brief notes upon their microscopic characteristics. Preceding this, Dr. Cooke now gives a description of the microscope and its essential accessories, with hints on their manipulation, and on the collection and mounting of the different classes of objects enumerated. The book is thus now a complete guide for beginners of practical microscopy, and will be of assistance to all who have a microscope and wish to know how to make good use of it.

THE number of cases of the production of true nitro-derivatives in the fatty series by direct nitration with fuming nitric acid is practically limited to the work of Franchimont and Klobbie and Ruhemann and Orton on malonic acid derivatives. In the current number of the *Comptes rendus*, MM. Bouveault and Wahl give the results of some successful experiments upon the direct nitration of unsaturated fatty compounds. With the ethyl ester of dimethylacrylic acid, a good yield of a mono-nitro-derivative is formed, which possesses acid properties, forming a potassium salt; from which, on treating with acid, an ethyl nitrodimethylacrylate isomeric with the original compound is obtained.

NEARLY forty years ago Schönbein showed how, on shaking lead amalgam with air and water, equivalent quantities of lead oxide and hydrogen peroxide were formed. In recent years many isolated cases have been described of this so-called autoxidation or simultaneous oxidation of two substances by air, one being incapable of oxidation by air alone—the researches of Bamberger,

and of Manchot in particular, proving the production of hydrogen peroxide in such cases. Engler has recently suggested that probably in all such cases hydrogen peroxide is formed simultaneously, half the oxygen molecule going to oxidise the substance present, and the other atom forming hydrogen peroxide. In many cases the formation of the latter substance is difficult to prove on account of its secondary oxidising action upon the substance used. In the current number of the *Berichte*, Dr. H. Biltz describes experiments on the oxidation of the hydrazone of dibromoxybenzaldehyde in alkaline solution by air at the ordinary temperature, and in this case he has been able to prove that the amount of oxygen in the hydrogen peroxide formed is exactly equal to the oxygen used up by the hydrazone.

THE same number of the *Berichte* also contains an account by Prof. Curtius of what appears to be a new general method of preparing aromatic aldehydes from the corresponding acids. By the action of dilute alkalis upon benzhydrazide,

$$C_6H_5.CO.NH.NH_2,$$

benzalbenzoylhydrazine,

$$C_6H_5.CO.NH.N:CH.C_6H_5,$$

is obtained, and this gives benzaldehyde upon hydrolysis with dilute acids. Prof. Curtius makes no attempt to explain the mechanism of this reaction, but states that a similar reduction in alkaline solution has been found to take place with many acid hydrazides with formation of the corresponding tertiary hydrazones

$$R.CO.NH.N:CH.R,$$

the latter being insoluble substances capable of easy isolation in a pure state, and in good yields. Distillation with dilute sulphuric acid then gives the corresponding aldehyde.

THE additions to the Zoological Society's Gardens during the past week include two Common Marmosets (*Hapale jacchus*) from South-east Brazil, presented by Lady Mackenzie; a Persian Gazelle (*Gazella subgutterosa*) from Central Asia, presented by Mr. B. T. Ffinch; a Red-necked Bustard (*Eupodotis ruficollis* ?) from South Africa, presented by Mr. J. E. Matcham; a Raven (*Corvus corax*), European, presented by Mr. F. Sykes; seven Gold Pheasants (*Thaumalea picta*) from China, presented by Mr. Henry G. Hobbs; a Carrion Crow (*Corvus corone*) captured at sea, presented by Mr. S. T. Henderson; a Bearded Tit (*Panurus biarmicus*), European, presented by Mr. A. R. Gillman; a Spotted Slow Skink (*Acontias meleagris*) from South Africa, presented by Mr. W. L. Sclater; a Green Lizard (*Lacerta viridis*), European, presented by Dr. Dyer; two Severe Macaws (*Ara severa*) from South America, two Spotted Eagle Owls (*Bubo maculosa*) from Africa, a Westerman's Eclectus (*Eclectus westermani*) from Moluccas, six —— Finches (*Munia*, sp. inc.) from India, two Simony's Lizards (*Lacerta simonyi*) from the Canaries, a Mocassin Snake (*Tropidonotus fasciatus*), a Caroline Anolis (*Anolis carolinensis*) from North America, two Leopardine Snakes (*Coluber leopardinus*), two Vivacious Snakes (*Tarbophis fallax*), an Œsculapian Snake (*Coluber longissimus*), a Four-lined Snake (*Coluber quatuorlineatus*), a Lacertine Snake (*Coelopeltis monspessulana*), South European, deposited; two Hog Deer (*Cervus porcinus*), two Dwarf Turtle Doves (*Turtur humilis*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN NOVEMBER.

Nov. 1. 9h. 11m. Minimum of Algol (β-Persei).
4. 6h. 0h. ,, ,, ,,
6. 9h. 54m. to 10h. 58m. π Arietis (mag. 5·6) occulted by the moon.
6. 13h. 47m. to 14h. 31m. ρ^3 Arietis (mag. 5·5) occulted by the moon.
11. 14h. 38m. to 15h. 56m. 1 Cancri (mag. 5·9) occulted by the moon.
12. 11h. 54m. to 12h. 58m. A^1 Cancri (mag. 5·6) occulted by the moon.
12. 14h. 45m. to 14h. 56m. A^2 Cancri (mag. 5·8) occulted by the moon.
14. 5h. Mars in conjunction with moon. Mars 7° 39′ N.
14–15. Epoch of the November meteors. Leonids. (Radiant 150 + 23.)
15. Venus. Illuminated portion of disc = 0·751.
Mars. ,, ,, ,, = 0·896.
15. Saturn. Outer minor axis of outer ring = 15″·99.
18. 13h. Venus in conjunction with moon. Venus 5° 51′ N.
21. 10h. 53m. Minimum of Algol (β Persei).
21. 19h. 23m. Eclipse of the sun invisible at Greenwich.
23. 5h. Jupiter in conjunction with moon. Jupiter 1° 3′ S.
23–24. Epoch of the meteoric shower of Biela's comet. (Radiant 25 + 43.)
24. 7h. 42m. Minimum of Algol (β Persei).
24. 12h. Saturn in conjunction with moon. Saturn 2° 8′ S.
27. 4h. 31m. Minimum of Algol (β Persei).
30. 6h. 11m. to 7h. 7m. κ Piscium (mag. 5·0) occulted by moon.

EPHEMERIS OF EROS FOR NOVEMBER.

Ephemeris for 12h. Berlin Mean Time.

1900.		R.A. h. m. s.		Decl. ° ′ ″
Nov. 1	...	2 15 8·32	...	+53 51 11·3
3	...	11 12·42	...	54 4 35·2
5	...	7 9·87	...	54 14 11·0
7	...	2 3 3·43	...	54 19 50·8
9	...	1 58 56·02	...	54 21 27·8
11	...	54 50·81	...	54 18 57·3
13	...	50 51·14	...	54 12 17·6
15	...	47 0·38	...	54 1 29·6
17	...	43 21·88	...	53 46 37·7
19	...	39 58·79	...	53 27 48·8
21	...	36 53·99	...	53 5 13·1
23	...	34 10·09	...	52 39 3·2
25	...	31 49·22	...	52 9 33·6
27	...	29 53·06	...	51 37 0·3
29	...	1 28 22·83	...	+51 1 40·1

FIREBALLS.—On Sunday evening, October 21, there appear to have been a remarkable prevalence of brilliant meteors. They were noticed at about 8h. 35m., 8h. 40m., 9h. 30m., 10h. and 11h. 58m. The first of these was a magnificent object, and it lit up the sky with three flashes which many people mistook for ordinary lightning. The night was very cold and clear throughout the country, and a great number of descriptions of the fireball alluded to have been published in the newspapers. Its flight was exceedingly slow from S.W. to N.E., and it appears to have been directed from a radiant point either in Capricornus or Aquila. The accounts are, however, somewhat conflicting. Near its disappearance the meteor had a height of between 20 and 30 miles over the Midlands, and a detonation was noticed at several places, including Tewkesbury and Clun, Shropshire.

On October 27, 11h. 42m., a magnificent meteor was seen by Mr. Denning at Bristol, traversing a path from 79° + 33° to 56° + 24¾°, and directed from a radiant at 136° + 34°. The object left a brilliant, irregular streak, one section of which remained visible in an opera glass for 13 minutes, during which time it drifted 17° in a southerly direction.

TEMPERATURE OBSERVATIONS DURING SOLAR ECLIPSE.—Mr. C. Martin made a systematic series of temperature observations during the eclipse of the sun on May 28, 1900, and his results are published in the *Scientific Proceedings of the Royal Dublin Society*, vol. ix. pt. 3, pp. 362–364. The observations were made with two instruments, one having a black bulb, the other with a white one. These were mounted about an inch apart on a black wooden post, some six feet high, the bulbs being six inches from any part of the woodwork, and pointed directly towards the sun. Parts of the first stages of the eclipse were rendered inactive by clouds, but for a period of two hours good readings were obtained. These are plotted as curves, the results from the two instruments being given both individually and in combination, the agreement being very close; if anything, the white bulb thermometer moved less quickly than the black,

and is thus the less sensitive of the two instruments. An examination in detail of these curves shows that the temperature was at its lowest about eight minutes after the middle of the eclipse, and began to rise rapidly as the eclipsed portions of the sun became less. The highest reading with the black bulb thermometer before the eclipse began was 63°·7, the lowest during eclipse being 35°·7, showing a fall of 28°. With the white bulb the corresponding readings were 15°·6 and 3° respectively, showing a drop of 12°·6.

DOMENICO CIRILLO AND THE CHEMICAL ACTION OF LIGHT IN CONNECTION WITH VEGETABLE IRRITABILITY.

ONE hundred and one years ago, on October 29, 1799, Domenico Cirillo, the Neapolitan Linnæus, was hanged on the market-place of Naples, together with some of the noblest among Italian men of letters and science. It is especially fitting to remember Cirillo in England, the country which he visited and where he had many friends, and for the literature and science of which he showed a special predilection—a country which unfortunately had such a fatal influence upon his destiny.

The Cirillos of Grumo, a village of Terra di Lavoro, were a family of doctors, naturalists and artists. At the beginning of the eighteenth century Nicola Cirillo was famed, both as a physician and a botanist. Following the best traditions of Neapolitan science, the traditions of Pinelli, of Imperato, and of Maranta, Nicola Cirillo instituted a private botanical garden, the only one then existing in Naples. In 1718 he became a Fellow of the Royal Society of London, and in connection with this Society, then presided over by Sir Isaac Newton, Nicola Cirillo began to collect meteorological data on the climate of Naples. After his death, in 1734, his botanical garden and his collections, together with the famous herbarium of Ferrante Imperato, were preserved, and the garden improved with the more recent systems of classification by Sante Cirillo, painter and naturalist, whose house became a centre of the learning and culture of Naples.[1]

Domenico Cirillo was born in 1739, and so profited by the education and influence of Sante, his uncle, of Nicola Capasso, Francesco Serao, and of other teachers, that at the age of twenty-one, in 1760, he successfully competed for the chair of botany in the University of Naples. Domenico Cirillo, indeed, followed in the track of Nicola, and soon became known both as a botanist and as a physician. In numerous botanical excursions he visited the greater part of the provinces of Southern Italy and Sicily; and he was the first to organise in this country a regular botanical survey, sending out pupils and assistants to collect in different provinces. Thus not only many rare plants were described in his "Fascicoli Plantarum rariorum Regni Napolitani," begun in 1788, but several new species were discovered. At present, in the Italian flora, about thirteen species of phanerogams are retained as first discovered and described by Cirillo.

That period, when men worked under the spell of Linnæus, was a time of great botanical fervour, of *furore botanico* to use Cirillo's expression, in the collecting and investigating of plants. Of Cirillo's early connection with Linnæus, botanists are still reminded by the name of the *Cyrillae*, which the great Swede dedicated to his young Neapolitan correspondent. Indeed, the devotion of Cirillo for Linnæus was so great that, following the impulse of his enthusiastic nature, he raised a monument to him in the old botanical garden of the Cirillo family.

Induced by Lady Walpole, Cirillo visited France and England, becoming connected with D'Alembert, Diderot, Nollet, Buffon, Franklin, Sir John Pringle, and especially with William and John Hunter. He was elected a Fellow of the Royal Society. In 1771 he published in the *Philosophical Transactions* an account of the Manna Tree of Calabria, Sicily and Monte Gargano, describing the method of extracting the manna. The *Philosophical Transactions* also contain his observations, made near Taranto, on the effect of the tarantola bite; Cirillo confirms what Serao, in 1742, had already written on *Tarantism*, dispelling the absurd superstition of the music-cure supposed to be effected by dancing the Tarantella. He observes how in Sicily the tarantola is never dangerous, and the music-cure is unknown.[1]

In the latter part of the eighteenth century, while the Neapolitan kingdom was freeing itself more and more from the baneful Spanish influence, during the early years of the reign of Ferdinand IV. and Maria Carolina of Austria, a spirit of reform and progress had risen in South Italy, and a new impulse was given to research in natural sciences. In medicine, after Francesco Serao and Domenico Cotugno, Cirillo rose above the rest. The researches and teaching of Giovanni Maria Della Torre and of Cirillo opened a new field to the Neapolitan naturalists in microscopical investigations. And around Cirillo, again, a new school of botanists and zoologists and of chemical investigators arose, among whom we may record the names of Filippo Cavolini, Vincenzo Briganti, Gaetano Nicodemi, Antonio Barba, Saverio Macrî, Antonio Fasano, Nicola Pacifico, Vincenzo Petagna, Matteo Tondi, Nicola Andria, Vincenzo Comi. The discoveries of Alberto Fortis in 1783, near Molfetta, where he observed the richness of the soil in nitrates, led to investigations in Naples on the origin of nitre, in which Fortis himself, Melchiorre Delfico, Giuseppe Giovene, Giuseppe Vairo and Zimmermann were chiefly engaged. In geological and mineralogical research Giov. M. Della Torre took the lead, and with him, or shortly after him, worked Ascanio Filomarino duca della Torre, Domenico Salsano, Gius. Gioeni, Gaetano De Bottis, Luigi De Curtis, Vincenzo Santoli, Domenico Tata, Scipione Breislak, Camillo Pellegrini. In 1788 Lazzaro Spallanzani began his tour to the volcanic regions of Southern Italy and Sicily. In those days Sir William Hamilton, during the many years of his residence in Naples, collected information on the Phlegrean Fields, while Ascanio Filomarino was forming his Vesuvian Museum, destined to so short an existence; for the museum and all the other scientific collections in the Filomarino Palace were destroyed in January 1799, when the unfortunate duke and his brother, Clemente Filomarino, the poet (the translator of Young's poems), were burnt as Jacobins by the infuriated Royalist mob.[2]

During this same period some of the more important foreign works were translated into Italian and published in Naples; such as the works of Stephen Hales, of Priestley, Linnæus, and the Agricultural Encyclopædia of Rozier.[3]

Omitting here all mention of his medical and other publications, Cirillo's chief works on botany and entomology were the following:—"Tabulæ botanicæ elementares," 1773; "De essentialibus nonullarum plantarum characteribus," 1784; "Entomologia Neap. Specimen primum," 1787-1790; "De Cypero Papyro," 1787, re-edited at Parma in 1796; "Fundamenta botanica, sive philosophiæ botanicæ explicatio," 1787; "Plantarum rariorum Regni Neapolitani," fasc. i. 1788, fasc. ii. 1793; "Discorsi Accademici," 1789, re-edited in 1799.

In the field of vegetable physiology, the discoveries of Cirillo on the irritability of plants are noteworthy. In that field, together with his contemporary, G. B. Dal Covolo, Cirillo is the

[1] Ferrante Imperato, whose herbarium was preserved in the Cirillo collections, lived at the end of the sixteenth century. In writing his "Historia naturale," printed in Naples in 1599, Imperato put together a museum which soon became known in Europe; for besides having for fellow-workers in Naples B. Maranta and Fabio Colonna, Imperato corresponded with P. A. Mattioli, Gaspard Bauhin, Ulisse Aldovrandi, Melchiorre Guilandino, and others of the foremost botanists of the time. His herbarium is said to have been composed of eighty volumes. The museum of Imperato got dispersed during the plague of 1656, and Nicola Cirillo eventually obtained possession of only nine volumes. After the sacking of Domenico Cirillo's house in 1799, one volume only of the Imperato herbarium was saved, and is now in the Biblioteca Nazionale of Naples. It contains 440 dried plants, *i.e.* about one-seventh of all the plants identified in the days of Imperato and Bauhin. This herbarium, together with the herbarium of Cesalpino, is among the rarest of botanical relics.

Of the herbarium of Domenico Cirillo a small remaining portion is now preserved in the botanical museum of the Agricultural College of Portici, in the care of Prof. O. Comes.

[1] The music-cure for the tarantola bite is still practised by peasants, especially women, in some parts of the province of Lecce and in Calabria. In Cirillo's days the belief in the dangerous and strange effects of the bite of the tarantola was held even by persons high in authority. See Andrea Pigonati, "Sul Tarantismo," Opuscoli Scelti ii. (Milano, 1779). Compare Franc. Serao, "Della Tarantola o sia Falangio di Puglia" (Napoli, 1742).

[2] Duca della Torre, "Descrizione del Gabinetto Vesuviano da lui posseduto" (Napoli, 1796, 2da ed.).

[3] The works of Hales were translated by a lady, Maria Ardinghelli; St. Hales, "Statica dei Vegetabili ed Analisi dell' Aria, trad. dall' Inglese con varie annotazioni da M. A. Ardinghelli" (Napoli, 1756).

St. Hales, "Emastatica, ossia Statica degli Animali. Esperienze idrauliche fatte sugli animali viventi" (Napoli, 1776).

Gius. Priestley, "Sperienze ed Osservazioni sopra diverse Specie di aria, trad. dall' Inglese" (Napoli, 1784).

The translation of Rozier's Encyclopædia was begun in 1783, and was due to the Società Letteraria di Napoli, of which Cirillo was one of the leading members.

Vincenzo Petagna began editing the "Species Plantarum" of Linnæus.

direct successor of his celebrated compatriot, Alfonso Borelli, who, in 1653, discovered in Naples the irritability of the anthers of *Centaurea*, and of other Cynareæ. In his essay, "Del Moto e della Irritabilità dei Vegetabili," published in 1789, Cirillo briefly describes what was then known of the sleep of plants, of the movements of the leaf blade of *Dionoea muscipula*, and of the fly-trap concealed in the flowers of *Aposynum androsaemifolium*, a plant then lately studied by Francesco Bartolozzi in Milan.[1] Cirillo quotes Linnæus' description of the movements of the *Hedysarum gyrans*, first discovered by Pohl in 1779. After describing the irritability of the stamens of the Cynareæ, the gradual sensitiveness of the flowers of Verbascum to shocks, and the recent observations of Duhamel and of others on the stamens of *Berberis*, and of *Parietaris officinale*, Cirillo goes on to describe his own discoveries of irritability in *Forsckohlea tenacissima*, and in the common nettle, *Urtica dioica*. "The study of the very complex fructification of the first plant (*Forsckohlea*) having revealed to me the spiral structure of the filaments, similar to those of *Parietaria*, I was led to verify whether these filaments also possessed irritability. It is of great interest to observe in the nettle, during the warmer morning hours, how the male flowers open abruptly, and suddenly burst open their well-closed anthers, that eject abundant fertilising dust."[2]

These observations brought Cirillo to believe that the "marvellous irritability of the sensitive plant, as well as the elasticity in the stamens of flowers, must be partly due to the spiral structure of the organs in which the contractions take place, chiefly, however, to the very frequent articulations of which these parts, so mobile and so irritable, are essentially composed."

Hedwig had in these years opened the way to the knowledge of mosses; and Cirillo again observed cases of irritability and elasticity in the capsules of mosses and in the filaments they contain, the articulated structure and the spiral form of which again confirmed his opinion on the mechanism of plant movement.[3]

In studying the sensitive plant, Cirillo points out the enlargement at the insertion of each leaf; and observing what he believed to be a spiral structure within this "tubercle-like body," suspects a connection between the spiral structure and leaf-movement. Comparing the *Mimosa pudica* with the *Mimosa glauca*, Cirillo finds that the great difference in their sensitiveness corresponds with the different size and development of the articulations containing the spiral structure. This *spiral structure* corresponds, of course, with the fibro-vascular bundle inside the *pulvinus*, the motor organ, in which, as we now know, the sap tension suddenly sinks at every cause of irritation.[4]

Following the ideas of Haller, the first to have a notion of protoplasm as the physical basis of life, Cirillo believes that the seat of irritability and of life, both in animals and in plants, must be in mucilaginous substances. Thus he points out that in plants "glutinous principles" are commonly met with which must be the seat of motion, of contraction, and of irritability. Curiously enough, as an example of this glutinous principle, Cirillo gives the "elastic resin now used so extensively" extracted from the sap of *Jatropha elastica*, and existing, as he observes, in many other plants. In that time, when only impure rubber was in commerce, it had been observed that this substance, besides strongly-smelling empyrheumatic products, yielded ammonia by distillation; it was therefore generally considered of the same nature as glutinous animal substances.[5]

1 Fr. Bartolozzi, "Sopra la qualità che hanno fiori della pianta detta Apocynum Androsæmifolium di prendere le mosche, con una osservazione nuova sulla fecondazione delle piante," Opuscoli Scelti ii. (Milano, 1779, p. 103; and iv. 1781, p. 73).

2 Besides G. B. Dal Covolo, "Discorso della irritabilità di alcuni fiori, nuovamente scoperta" (Firenze, 1764), compare with the observations of contemporary botanists—G. E. Smith in England, and Des Fontaines in France. An abridgment of these observations was published in Italian at Milan: Des Fontaines, "Sull' Irritabilità degli organi sessuali di molte piante," Opuscoli Scelti x. 1787, p. 417; G. G. Smith, "Sopra la irritabilità dei vegetabili," Op. Scelt. xi. 1788, p. 379.

3 See also Antonio Barba, "Osservazioni sopra la generazione dei Muschi," Op. Scelt. v. 1782, p. 128. Barba was a pupil of Cirillo and of Della Torre.

4 See also Andrea Comparetti, "Nouvelles Recherches sur la Structure organisée relativement à la cause des mouvements de la sensitive commune". (*Mém. Acad. de Turin*, 1790).

5 It is interesting to remember that in those days, in London, Tiberio Cavallo was first beginning to prepare india-rubber tubing for scientific use, the tubes being made from an ethereal solution of the india-rubber. See Faujas St. Fond, "Su alcune arti utili, tratte da un viaggio in Inghilterra, in Scozia, e alle Isole Ebridi," Op. Scelt. xx. 1797, p. 60.

For the first applications of india-rubber in making waterproof cloth, &c., and for a description of Grossard's method of making india-rubber tubes, see Cervantes, "Resina Elastica," Op. Scelt. xxi. 1798, p. 97.

The researches of Hunter, showing the connection between nerve-action and electricity in the torpedo, and the experiments that Cirillo's friend Italisckhi was making in Naples on the electrical organ of the torpedo, brought Cirillo to believe that there must be some special connection between electricity and the action of nerves, and in general with all manifestations of irritability. As is well known, that was an active period of research on the torpedo: suffice it to record the names of Walsh, Pringle, Spallanzani, Soave. At Naples, in 1784, Domenico Cotugno accidentally received an electric shock in vivisecting a young mouse: this on the eve of Luigi Galvani's discoveries in animal electricity. This was also the period of greater fervour in experimenting upon the influence of electricity on vegetation. These experiments were chiefly carried out by Achard in Germany, Berthelon in France, Toaldo, Gardini and Vassalli in Italy and by Ingen-Housz in England. Vassalli and Rossi were soon to show the excitability of the sensitive plant under electric action.[1]

The connection of the chemical action of atmospheric air with respiration, and with all forms of animal and vegetable motion, was evidently in the mind of Cirillo. Indeed, for many years scientific research in Italy, both on animal and vegetable life, had been discovering more and more this connection, preparing the way to modern knowledge of respiration and of the origin of vital heat and of vital motion.

Fracassati, in 1665, had observed the change of colour in blood when shaken up in air. The experiments of John Mayow, the pre-discoverer, if the term may be used, of oxygen, were perhaps better known and appreciated in Italy than in England, through Ludovico Barbieri, of Imola, who translated and extended the work of the English chemist. Barbieri observed that the bright colour of arterial blood must be due to impregnation with nitro-aërial spirit; and he showed, by experiments on the transfusion of blood into an animal prevented from breathing, the truth of Mayow's teaching, that atmospheric nitro-aërial spirit, fixed in the blood, sustains life and, as in the case of the flame, produces heat. Barbieri also taught that the nitro-aërial spirit of the air causes the germination of seeds and sustains the life of plants.[2]

Hales, during the first part of the eighteenth century, had shown how plants suffer when enclosed in gases other than air, as the "air" extracted by distillation from Newcastle coal. Bonnet and Duhamel observed subsequently that leaves perish when covered with oil. But to Buonaventura Corti, the discoverer of protoplasmatic movements in the vegetable cell, is due the first exact proof of respiration in plants. Corti showed, in a series of experiments, that when air is excluded from the vegetable cell all circulation of the cell-sap is arrested: "now that we have shown," he observes, "that the circulation of the sap of the Chara is arrested when *in vacuo*, we readily understand why all plants perish without air, and why seeds cannot germinate without air, or perish shortly after sprouting."[3] In those days, in 1773, Francesco Cigna, in Turin, was again proving the action of air upon the colour of blood, and the influence of blood upon the properties of air. Cigna's experiments were repeated with greater exactitude, after the discovery of vital air, by Priestley, who showed that vital air, *i.e.* oxygen, causes the blood to brighten, while its colour deadens in contact with other gases. The discoveries of Priestley were followed, in 1779, by Adair Crawford's theory and experiments on respiration and animal heat.[4] According to Crawford, the latent heat of atmospheric air gradually becomes perceptible as animal heat, while the air absorbed through the lungs gets mixed and retained in the blood, which yields its phlogiston to the atmosphere. Crawford held that vegetable matter is elaborated, and becomes charged with phlogiston, under the action of solar rays; whilst during the combustion of vegetable matter phlogiston is again yielded up to the atmosphere and fire generated, in the same way blood generates heat, while phlogisticating expired air. Vegetables again, growing under the influence

1 Cotugno's observations on the electrical mouse are described in a letter to Vivenzio. See Tiberio Cavallo, "Teoria e Pratica dell' Elettricità Medica" (Napoli, 1784, p. 157). This is an Italian translation by Vivenzio; the original English work was published by Cavallo in London, in 1780.

2 "Planta a spiritu nitro-aereo prima vitæ stamina suscipit," wrote Barbieri in 1680. See Salvigni, "Ragionamento sopra alcune dottrine chimiche di Giovanni Mayow e di Ludovico Barbieri" (Bologna, 1816).

3 B. Corti, "Osservazioni microscopiche sulla Tremella e sulla circolazione del fluido in una pianta acquajuola" (Lucca, 1784, p. 191).

4 An Italian abridgment of Crawford's paper was published very soon after its appearance in England: Adair Crawford, "Sul calore animale e sull' infiammazione dei corpi combustibili," Opuscoli Scelti iii. 1780, p. 73.

of light, separate phlogiston from the tainted air, and repristinate in the atmosphere the power of generating heat by combustion or by respiration. A cycle of the principles of heat and of phlogiston is thus maintained through atmospheric air between the vegetable and animal kingdoms. Substituting the old conception of phlogiston by the modern idea of energy, we perceive in Crawford's theory the germ of the theory of the preservation and transformation of energy. Crawford's work prepared the way, as Carradori pointed out in 1792, to Lavoisier's experiments on respiration, and for the ready acceptance of his theory.

In Italy, where the experiments of Marsiglio Landriani, of Pietro Moscati and of Lazzaro Spallanzani, were then showing the influence of different gases on cutaneous respiration, and where Spallanzani was demonstrating the evolution of fixed air even from tissues separated from the living body, and in organisms prevented from absorbing free vital air, the theory of Crawford was readily accepted, and served as a starting-point to the experiments of Michele Rosa in Modena. Rosa, indeed, followed directly in the track opened by Ludovico Barbieri a century before. By a numerous series of experiments in transferring arterial blood into animals prepared by copious bleeding, and by the different comportment of arterial and venous blood *in vacuo*, Rosa showed that the vital principle has its seat chiefly in the blood, and is maintained by the continuous action of atmospheric air during respiration, being due to the same cause that maintains combustion. Rosa's work has not been sufficiently appreciated because of his misapplication of names, and was too soon forgotten in the great light shed by the experiments of Lavoisier; but there is no doubt that to Rosa is due the first demonstration of the incorporation of oxygen in the blood, of the special labile condition of its combination, and of the supreme importance of aëration for the vitality of all animal tissues.[1]

When Cirillo wrote his essays, the theories of Crawford and of Rosa were in their bloom, and were warmly espoused by the Neapolitan naturalist. Cirillo believed that all life, animal and vegetable, had its origin in the action of air upon the "glutinous principle," that is, the basis of life in all tissues, and that light, electricity and heat, but especially solar light, are all connected with the quickening of life. Like Lavoisier, Cirillo looked upon sunlight as the origin of all life: "Sunlight," he wrote, "the only, the inexhaustible, primitive and incomprehensible fount that pours heat and motion and life upon our globe."

John Hill, in his letter to Linnæus in 1753, had shown the special connection of light, independently of heat, with the sleep-movements of plants. Priestley's celebrated experiments on the purifying action of vegetation upon air vitiated by respiration, or by combustion, had been known since 1772. In 1779 Ingen-Housz pointed out that this action of plant-life is due to sunlight, and only takes place when light acts upon green plants. Cirillo himself must have observed the attraction of lower organisms towards light, similar to those swarm-spore movements that shortly after were first described by Giuseppe Olivi.[2] "Why," asks Cirillo, "do all polyps love light, so that, on darkening the vase in which they are contained, leaving free only a tiny hole, they all forsake darkness, and throng near the spot where they can enjoy the immediate action of the solar rays? Why are all marine animals so filled with a luminous vapour, emitting phosphoric light? Why are the most irritable fish phosphorescent and electric? Why do plants, when deprived of solar light, lose colour, aroma and robustness?" Cirillo, like most of the writers of his time, was not clear in the distinction between light and heat; but what is predominant in his mind is that all movement, both in animals and in plants, is due to fixation of vital air, to oxidation, and that light therefore, by causing the sleep-movements in plants, must be connected with some process of oxidation.

While Cirillo was writing, Senebier had already shown (1788) that the chief action of light in plants is the reverse of oxidation, causing the decomposition of carbonic acid and the evolution of oxygen. The importance of this discovery, and the mistaken notions about plant-respiration, caused what may be called the minor functions of light in plants to be neglected. Only long after the days of Cirillo and of Senebier, in the latter part of our century, investigations began on the influence of light in respiratory processes: in the decomposition of chlorophyll, in changing the composition of the sap, and the distribution of osmotic tension, and consequently in causing the movement of plant-organs, as in the case of nyctitropic and heliotropic movements. These changes are promoted, as was first shown by Michelangelo Poggioli in 1817, by the more refrangible rays of the spectrum, by those rays, namely, that are specially active in causing the oxidation of organic compounds and in decomposing silver and other salts.

Cirillo's opinions on the chemical activity of solar rays were due to his own original observations on the chemical action of sunlight upon silver chloride. His experiments were made to test the truth of an assertion by Nicola Andria that certain Ischia waters contained phlogisticated alkali (yellow prussiate), and could consequently produce Prussian blue.[1] "A curious phenomenon," Cirillo writes, "has been recently observed by me whilst analysing the Olmitello water of the Island of Ischia. Investigations of our chemists had brought them to believe that this water contained a phlogisticated alkali, similar to that prepared from the colouring matter of Berlin blue; for, on mixing the water with some *luna cornea*, or with a solution of silver in nitrous acid, not only was a white substance instantly produced, but after a short time it changed to a very beautiful and dark azure colour. This experiment, seeming to show the existence of a phlogisticated alkali in the Olmitello water, having been accidentally repeated by me towards evening, I observed that the mixture remained white during the whole night, becoming azure only on the following morning, after the rising of the sun. I also noted that the intensity of the azure colour in the sediment increased with the growing intensity of sunlight. These results led me to repeat the experiment while excluding all action of light. To half a glass of Olmitello water I therefore added a few drops of the solution of silver in nitrous acid; and as soon as the white precipitate due to the alkali was formed, I shut the glass in a place utterly impenetrable to light. For many days the precipitate remained white; but on exposure to light it became cerulean in a few minutes. The same change was observed in a water from Calabria; for, on treating it as the Olmitello water, it also rendered blue the *luna cornea*. Also our common waters, probably charged with an alkaline earth, undergo the same change. I am aware of what recent writers have said about the repristination of metals by solar heat; nor do I ignore how with a burning lens the illustrious Priestley, heating inflammable air in contact with minium inside a glass vessel, was able to repristinate lead. But my experiment will serve at least to correct the error of those who analysed the Olmitello water, believing it to contain a phlogisticated alkali, similar to the Prussian alkali; and secondly, this experiment gives us a sure proof of the energy of solar rays in repristinating metals. These observations, although having a distant connection with the movements and irritability of vegetables, are also worthy of record in connection with other considerations which I hope shortly to publish."

Cirillo's essay was published, in its first edition, in 1789, so that the Olmitello experiments must have been made shortly before that year and after Andria's last publication of 1783. As is well known, the experiments of Scheele (not counting the earlier, forgotten experiments of J. H. Schultze in 1727) were published in Swedish in 1777; a French translation, by Baron Dietrich, of Scheele's treatise on Air and Fire appeared in Paris in 1781.[2] Scheele's experiments on *luna cornea* and other silver salts are quoted and commented upon by Felice Fontana in 1783.[3] Senebier, in 1782, had been experimenting on the rapidity of action of different lights upon silver chloride.[4] Cirillo therefore ought to have been acquainted with Scheele's experiments, although there is every reason to believe that he, generally so precise in recording previous work, was not aware that, only a few years before his own experiments with the Ischia water, the action of light upon silver salts, and especially

[1] Michele Rosa, "Lettere fisiologiche," 3da ed.; "Colle osservazioni ed Esperienze sul Sangue fluido e rappreso dal Signor Pietro Moscati," 2 vols. (Napoli, 1788).
This edition is dedicated to Domenico Cirillo. The experiments of Rosa were first published in Vicenza in 1782. The experiments of Lavoisier on animal respiration, first published in Paris in 1777, appeared in Italian in 1781 (Opuscoli Scelti iv. 1781, p. 135).

[2] Giuseppe Olivi, "Delle Conferve irritabili, e del loro movimento di progressione verso la luce, Esame chimico" (*Mem. di Mat. e Fisica della Soc. Italiana*, tom. vi. Venezia, 1793).

[1] Nicola Andria, "Trattato delle acque minerali," 2da ediz. (Napoli, 1783).

[2] Ch. Giul. Scheele, "Traité chymique de l'air et du feu." Trad. Dietrich. (Paris, 1781).

[3] Felice Fontana, "Sopra la Luce, la Fiamma, il Calore, ed il Flogisto" (Opusc. Scelti vi. 1783).

[4] Jean Senebier, "Mém. physico-chymiques sur l'influence de la Lumière Solaire, pour modifier les êtres des trois règnes de la Nature" (Génève, 1782).

the action of the more refractive rays of the spectrum, had been demonstrated and studied by the highest chemical investigator of the time, who had died in 1786. Cirillo's observations are, however, worth recording, because they were connected in his mind with the action of sunlight in causing movements and irritability in vegetable organs.

Other workers in those days were investigating in Italy the chemical action of light; and their experiments, like those of Cirillo, are also generally forgotten. In 1782, Alessandro Barca, in Padua, studied the effect of solar rays in accelerating the decomposition of phlogisticated alkali, or yellow prussiate, in the presence of acetic acid.[1] In 1794, Anton Maria Vassalli, in Turin, in comparing the action of solar and of artificial light, showed that the latter darkens silver salts, causes chlorotic leaves to become green, rouses the sleeping leaves of the sensitive plant, and acts generally in the same manner, although with less intensity, as the light of the sun. Vassalli observed a diminution in weight in the silver chloride darkened by light; he also experimented upon the effect of moonlight upon this salt, and upon vegetation.[2]

The "Discorsi Accademici" of Cirillo, in which are the two remarkable essays, "Del moto e della irritabilità dei vegetabili" and "La cagione della vita," were first published in 1789, and re-edited in 1799. This second edition was the last scientific labour of Cirillo, for in that same year he was overwhelmed in the political storms that swept over Naples. All the writings of Cirillo glow with warm philanthropy and patriotism, and we see in them a constant protest against the prejudices and superstitions then so high in authority in the Neapolitan kingdom. After the cowardly flight of King Ferdinand from Naples in December 1798, leaving the city a prey to royalist anarchy, Cirillo joined with the patriots who favoured the entrance of the French into Naples and the establishment of the Parthenopæan Republic. Pressed by the insistance of his friends, Cirillo accepted the presidency of the legislative body, but during the brief period of his political power he occupied himself mainly in alleviating the growing misery of the people; above all, Cirillo remained the philanthropist and the physician rather than the politician. The Republic lasted a few months, sinking finally in the struggle with the brigand hordes of the Holy Faith, that through pillage and bloodshed Cardinal Ruffo led from Calabria to Naples. Cirillo was among the many who capitulated in the Castles of Naples, on condition of a free passage to a French port. The sorrowful history of what followed is well known, of how the capitulation was ruthlessly broken when Castles and prisoners were secured. All those who had held office under the Republic, or had any direct connection with its government, were condemned to death for high treason. From June 29, 1799, to September 1800, execution followed execution, until in Naples alone ninety-nine of the foremost men were put to death, besides the many—it is said 300—executed in the provinces. Domenico Cirillo was hanged on the same day as Mario Pagano and the poet Ignazio Ciaja. "For the death of these men all the city mourned," wrote Marinelli, a diarist of the time. Another botanist, Abate Nicola Pacifico, an old man of seventy, companion and fellow-worker of Cirillo, shared his fate on August 20, on the same day when the gifted Eleonora Fonseca Pimentel was delivered to the hangman.

Cirillo's house was pillaged by the mob, and his collections and books, among which was the herbarium of Imperato, were burned or dispersed. "Let the idle and ignorant know that love of humanity, zeal for science, and faithfulness to duty can only be quenched in me with my life"—thus wrote Cirillo in the days of his prosperity, little dreaming of the distant purport of his words. Nobly indeed, when oppression and ignorance prevailed, in the days of suffering and agony, Cirillo to the very last kept faith to duty and to Fatherland. ITALO GIGLIOLI.

[1] Alessandro Barca, "Sulla Scomposizione dell' alcali flogisticato" (Opusc. Scelti vii. 1783).
[2] Anton M. Vassalli, "Parallelo della Luce Solare e di quella della combustione" (Opusc. Scelti xvii. 1794, p. 106).

METALLIFEROUS DEPOSITS.

A COURSE of four Cantor Lectures delivered before the Society of Arts by Mr. Bennett H. Brough, on the nature and yield of metalliferous deposits, has just been published. Descriptions are given of the principal ore deposits of the world, and the statistics of production appended furnish a clear idea of the condition of the mining industry at the present time. The subject is of great importance from a commercial point of view, as will be evident from a moment's consideration of the enormous value of mineral resources. In the United Kingdom alone, the value of the minerals raised in one year has approached 80,000,000*l.*; and the vast sums representing the British capital invested in mines in all parts of the world will be readily appreciated. Last year, the number of new mining companies registered in Great Britain was 559, with a united nominal capital of 71,687,366*l.* Of these companies, 281, with a nominal capital of 37,037,057*l.*, were formed to mine and explore in British colonies and dependencies, and 157, with a nominal capital of 24,049,502*l.*, to mine in foreign countries. During the present century the mining industry has made remarkable strides. Some indication of the progress made, even during the past ten years, is afforded by a comparison of the world's output of metals in 1889 and in 1898. In round numbers, the production of the principal metals was as follows:—

	1889. Tons.	1898. Tons.	Value of output in 1898. £
Pig-iron	26,000,000	36,000,000	100,000,000
Gold	182	430	57,500,000
Silver	3,900	6,000	24,000,000
Copper	266,000	431,000	21,750,000
Lead	549,000	770,000	10,000,000
Zinc	335,000	468,000	9,950,000
Tin	55,000	77,000	8,000,000
Antimony	11,000	28,000	1,100,000
Mercury	3,838	4,100	815,000
Nickel	1,830	6,200	725,000
Aluminium	70	4,000	440,000

The simplest classification of the ore deposits from which these vast outputs have been obtained, divides them into (1) beds, (2) veins, and (3) masses. This classification has proved well adapted for practical use. The more elaborate systems of classification that have from time to time been proposed are fully discussed, the classifications dealt with being those of Agricola (1555), Burat (1855), B. von Cotta (1853), Grimm (1869), J. A. Phillips (1884), A. von Groddeck (1878), F. Pošepný (1880), Sir A. Geikie (1882), H. S. Monroe (1892), H. F. Kemp (1892), H. Louis (1896), H. Hoefer (1897) and G. Gürich (1899). The last-named investigator uses the mode of concentration as the basis of classification. The concentration may take place with or without a change in the state of aggregation. In the former case the passage into the solid state is from a state of vapour, from a molten state, or from a state of aqueous solution. Consequently the following classes of ore deposits are distinguished:—

I. Sublimation deposits: (*a*) syngenetic, in which the sublimation of the vapours takes place simultaneously with the solidification and within a solidifying magma, *e.g.* tin ore deposits; (*b*) epigenetic, in which crusts are formed coating fissures; (*c*) metagenetic, in which the constituents of a rock are dissolved by pneumatolysis and replaced by metallic substances.

II. Magmatic, or solidifying deposits: (*a*) syngenetic, representing the usual form of magmatic deposit as described by Vogt; (*b*) epigenetic, only imaginable if an apophysis of a magma within the enclosing rock consists of a metallic band; (*c*) metagenetic, hardly imaginable.

III. Precipitation deposits: (*a*) syngenetic, in which the chemical precipitation takes place simultaneously with the sedimentation, the deposit being formed simultaneously with the surrounding rock, *e.g.* seams, beds; (*b*) diagenetic, in which the concentration takes place in the muddy floor of a lake, *e.g.* concretionary nodules of clay iron ore; (*c*) epigenetic, in which the deposit is formed subsequently to the surrounding rock, *e.g.* veins, cave fillings; (*d*) metagenetic, in which the soluble constituents of a rock are dissolved, transported, and the metallic substance precipitated, the deposit being formed subsequently to the enclosing rock, but growing at the expense of the latter.

IV. Separation deposits: (*a*) residual deposits formed by chemical concentration, a soluble rock constituent, *e.g.* lime, being carried away, and a metallic substance, *e.g.* brown iron ore, remaining unaltered; (*b*) detrital deposits formed by mechanical concentration, *e.g.* dry placers, alluvial deposits.

In view of the apparent impossibility of definitely determining the genesis of a given deposit, it may be questioned how far it is advisable to adopt a genetic classification. Probably, however, by employing that system of classification, an observer would be induced to make a more thorough examination than if he were

required merely to define the deposit by its outward form. Any efforts to introduce improvements in mining must, however, subordinate theory to practical requirements.

In consequence of the difference of form in beds, veins and masses, various methods of working have to be employed. Underground mining is not necessary with all ore deposits. The iron ore beds of Northampton, for example, and the alluvial beds of river gravel containing gold are worked open-cast.

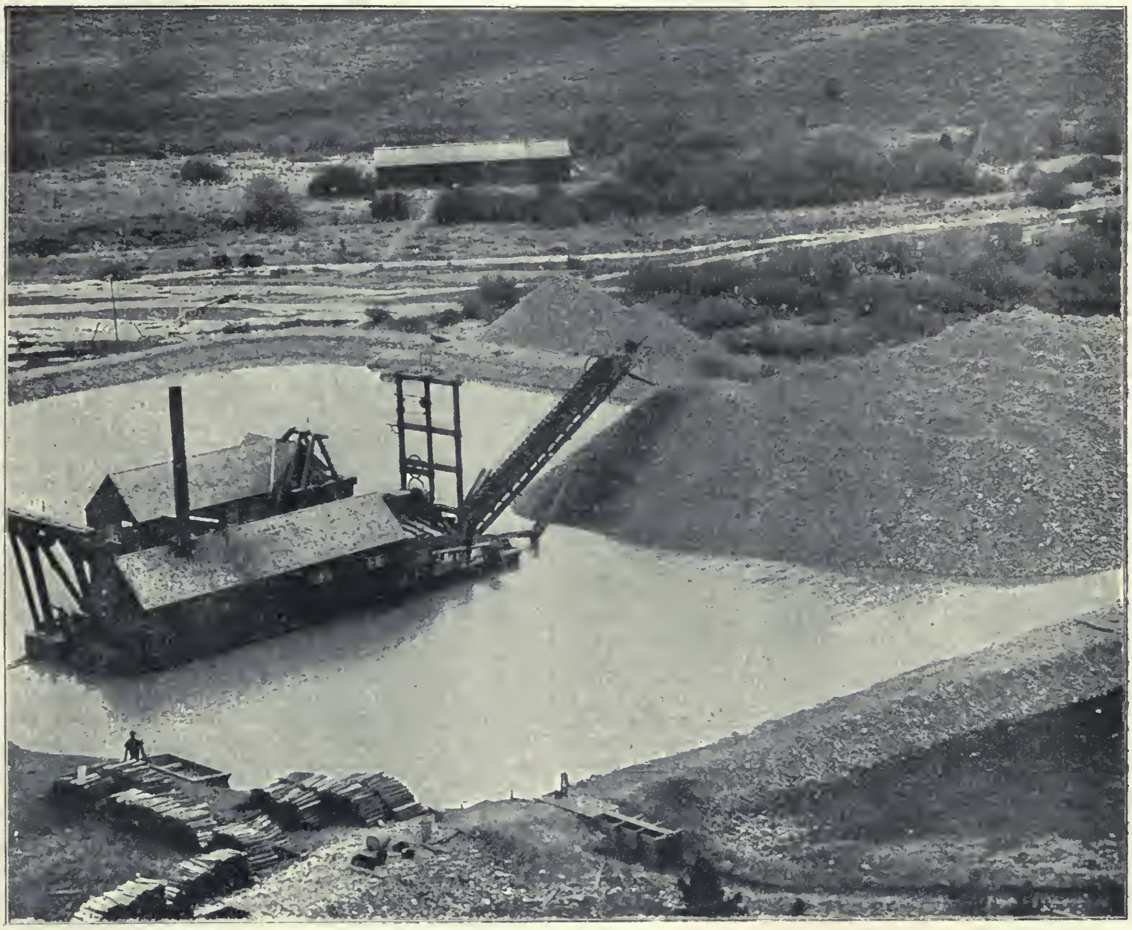

FIG. 1.—Gold Dredge at work excavating auriferous Gravel 45 feet below the Water Surface.

Of late years very successful results have been obtained by extracting auriferous gravels from the beds of rivers by dredges. The practice of dredging originated and has been brought to its present state of perfection on the Clutha river, in the province of Otago, New Zealand. Ground containing only a grain or a grain and a half of gold per cubic yard can now be worked at a profit. The remarkable yield of a dredge working at Cromwell, on the Clutha river, which cost 5,000*l*. to build and launch, and obtained more than that amount of gold within seven weeks after starting, shows how quickly the capital sunk in the industry has, in some instances, been returned. Experience in Montana, United States, shows that with a bucket-dredge 98 per cent. of the gold in the gravel is extracted. The cost of dredging when steam is employed is $4\frac{1}{2}$*d*. per cubic yard, and when electricity is employed for power $2\frac{1}{4}$*d*. per cubic yard. The practice of dredging is coming into increasing use in New Zealand, Canada, California, Montana, the Republic of Colombia, and elsewhere. It represents an important advance in the working of alluvial deposits, and if the yields of gold in the future are not likely to be so sensational, they will probably be more regular than they have been in the past. The accompanying illustration (Fig. 1) shows the latest type of gold dredge made by the Risdon Ironworks of San Francisco. As represented, it is excavating auriferous gravel 45 feet below the water, and stacking it 24 feet above.

The gradual increase in the world's annual production of gold is shown in the accompanying diagram (Fig. 2).

The value of the world's gold production in 1898 was 57,500,000*l*., of which the Transvaal produced 27·6 per cent., Australasia 22·5 per cent., the United States 22·1 per cent., Russia 8·8 per cent., Canada 4·8 per cent., Mexico 3 per cent., India 2·7 per cent., and China 2·1 per cent. Thus the Transvaal, Australasia, and the United States together produced 72 per cent. of the total. The production last year was even greater, amounting probably to 62,700,000*l*., notwithstanding

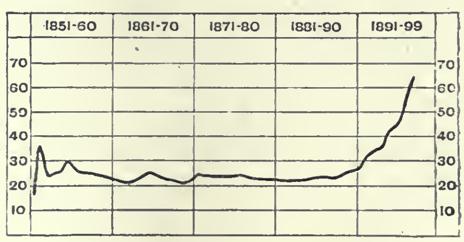

FIG. 2.—World's gold production (in millions of pounds).

the interruption in Transvaal mining. From the present condition and prospects of the more important mines in Africa, Australasia, the United States, Canada and other countries, it seems that there are no signs of falling off in the world's gold

production. In the case of silver, of which the world in 1898 produced 165,000,000 ounces, Mexico produced 34·4 per cent., the United States 33 per cent., and Australasia 7·3 per cent. Less than half the world's supply was obtained from silver ores. The remainder was obtained from the metallurgical treatment of other ores in which silver was an accessory constituent. Since those ores would continue to be mined for the other metals they contained, a steady supply of silver was assured, whilst a slight rise in the price of silver would enable many deposits of true silver ores now untouched to be worked.

In a paper read before the Society of Arts in 1854, Mr. J. K. Blackwell stated that the world's production of pig iron then amounted to 6,000,000 tons. Of that quantity the United Kingdom produced 50 per cent., France 12·5 per cent., the United States 12·5 per cent., and Germany 6·6 per cent. In 1898 the world's production had risen to 35,741,000 tons, of which the United States produced 32·7 per cent., the United Kingdom 24·1 per cent., Germany 20·6 per cent., and France 7·1 per cent. The relative position of the different countries from a mining point of view is better shown by the statistics of iron ore production. The world's production in 1898 was 73,670,000 tons, of which the United States produced 26·2 per cent., Germany 21·6 per cent., the United Kingdom 19·3 per cent., Spain 9·7 per cent., France 6·2 per cent., Russia 5·6 per cent., Austria-Hungary 4·5 per cent., and Sweden 3·1 per cent. The more important iron ore deposits now worked are at the mines of Lake Superior, Bilbao, Southern Spain, the Ural, Styria, Dannemora, Grängesberg and Gellivare.

With regard to copper, the rapid decadence of British copper mining was owing to copper in the Cornish mines having given place to tin as greater depths were reached, and to these great depths and the quantity of water encountered rendering competition with the American and Spanish deposits impossible. There are, however, large areas unexplored, and many mines worth re-opening should the price of copper rise, and should the disadvantages experienced in Great Britain make themselves felt abroad. Owing to the increased demand for copper caused by the rapid extension of the applications of electricity, a further rise in price is not improbable. The world's production of copper in 1898 was 424,126 tons, of which amount the United States produced 55·1 per cent., Spain and Portugal 12·6 per cent., Japan 5·9 per cent., Chili 5·8 per cent., Germany 4·9 per cent., Australasia 4·2 per cent., Mexico 2·5 per cent., Canada 1·9 per cent., Cape Colony 1·6 per cent., and Russia 1·4 per cent. Last year the world's copper production was about 474,000 tons. The Anaconda Mine produced 11 per cent. of the world's output, and among other important copper mines are those in Arizona, in the Lake Superior district, in the South of Spain (Rio Tinto and Tharsis), and Portugal (San Domingos), in South America, in Japan; at Mansfeld, and at the Rammelsberg, in Germany; at Falun, in Sweden; and in Australasia (Mount Lyell, Tasmania; Moonta and Walleroo, South Australia; and Great Cobar, New South Wales).

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION.

THE first meeting of the Conference took place at Bradford on Thursday, September 6.

The report of the Committee, a copy of which was in the hands of every delegate present, was taken as read. The chairman then remarked that the chief subject for discussion that day consisted of the following resolutions, which had been brought forward by the Yorkshire Naturalists' Union:—

(1) That the Conference of Delegates be allowed to meet on the first day of the British Association meeting, and make their own arrangements for subsequent meetings and order of business.

(2) That it is desirable, in order to make the discussions of the Conference of Delegates more useful to the local societies, that they should have the power of deciding the subjects for discussion at the meetings of the Conference, and it is suggested, therefore, that a circular be sent by the Committee every year to each of the corresponding societies asking them to send a list of subjects for discussion (not more than two or three) at the forthcoming meetings. The Committee then to send to the corresponding societies a schedule containing the titles of all the subjects proposed for discussion, asking each society to mark such of these subjects as it deems most desirable to discuss at the Conference meetings. On receipt of this information the Committee will then arrange the list of subjects in order of precedence as indicated by the support given to each subject by the societies; and a copy of this should be sent to the delegates or Societies as an agenda paper before the first meeting of the delegates.

After a long discussion, it was resolved that the meetings of the Conference be held on Thursday and Tuesday, as heretofore.

Copyright.—Mr. Walton Brown remarked that some time ago Lord Monkswell had introduced a Bill into Parliament dealing with copyright, but so far as scientific societies were concerned the Bill ignored some important points. There was no provision that a society should have any copyright in the publication of its own transactions. He believed that societies could claim copyright if they paid their contributors. He thought that the Conference should ask the Corresponding Societies Committee to take steps to have an amendment proposed recognising the copyright of scientific societies in their publications.

Prof. Henry Louis pointed out that the British Association expressly disclaimed copyright for themselves; and the Rev. J. O. Bevan urged that a special case should be prepared and submitted to counsel for a legal opinion. Mr. Walton Brown's views were unanimously accepted by the meeting, which then adjourned.

At the second meeting of the Conference an address on dew-ponds was given by Prof. Miall. In the first place, Prof. Miall noticed the mention of dew-ponds by Gilbert White ("Natural History of Selborne," Letter lxxi.), and more recently by the Rev. J. C. Clutterbuck in a prize essay on "Water Supply." Both writers described them as existing on the tops of chalk hills, and Mr. Clutterbuck says that at the selected spot an excavation is made from 30 to 40 feet or more in diameter, and from 4 to 6 feet deep. The bottom is covered with clay mixed with lime, and a layer of broken chalk is placed over the clay with lime to prevent injury to this impermeable lining. Water is then introduced by artificial means. If there is a fall of snow this is collected and piled in the pond. Ponds so made have been known never to become dry during periods of twenty or thirty years. They are most common on the chalk hills of Sussex and Hampshire, and are also found in Berkshire and Wiltshire. But on the chalk of Hertfordshire, Bedfordshire, Lincolnshire and Yorkshire there are few or none.

As dew-ponds often occupy the summit of a ridge so precisely that they can have no collecting ground worth mentioning, and as any springs are hundreds of feet below, it becomes an interesting question why they retain more or less water when the low-level ponds of the same district have become dry, though they supply water for large flocks of sheep.

Prof. Miall then reviewed the evidence bearing upon the question whether these ponds are mainly dew-ponds or rain-ponds, and quoted the experience of Mr. Clement Reid, who found that at the end of a long drought the best dew-ponds were sheltered on the south-west side by an overhanging tree, or the hollow was sufficiently deep for the south bank to cut off much of the sun. The depth or shallowness of the water did not appear to make so great a difference as might be expected.

It was, however, evident that many additional observations were necessary before this question could be settled. It was desirable that the temperature of the water of the pond at various depths, as taken hourly through a summer night, should be noted, and that many other thermometrical observations should be made. He concluded by asking that residents in the south-eastern counties would investigate the matter.

Mr. Clement Reid had been working for some years in a country where dew-ponds were abundant, but did not think they were formed in the scientific manner pretended by their makers. In times of drought some dried up and others did not, the fittest surviving. Farmers were continually making new ones, and sometimes, by accident, hit on a satisfactory site It was unfortunate that they were almost entirely without meteorological observations on the high ground where dew-ponds might be seen.

Mr. Hopkinson noted the difficulty of ascertaining the amount of water contributed to the pond by dew. A distinction must be drawn between dew and mist. There were scarcely any rain gauges on the high ground where dew-ponds existed, though probably more rain fell there than in the valleys. He did not know of any dew-ponds in Hertfordshire. Mr. J. Brown and Mr. W. Gray stated that there were no dew-ponds in Ire-

land. Mr. W. M. Watts considered that the amount of dew could hardly exceed $1\frac{1}{2}$ inches per annum, and Mr. Barrowman was not aware of the existence of dew-ponds in Scotland. Mr. G. P. Hughes said that dew-ponds were unknown in his district (Berwickshire). He thought they might prove useful in Australia and South Africa, dry countries where the dews were heavy. The Rev. E. P. Knubley noted their existence in Wiltshire, and Prof. H. Louis thought that the exact composition of the water in these ponds was one of the essential points to be examined. Prof. Potter noted the existence of ponds in Warwickshire, Suffolk and the South of Portugal, which he thought might prove analogous to dew-ponds.

Prof. Miall referred to various points which had been raised in the discussion. Ponds to be classed with dew-ponds must not be fed by springs or surface drainage. He had hitherto found that ponds in the Midland counties, supposed to be analogous to dew-ponds, were not really so. He hoped that the corresponding societies would take up the subject.

Section C.—Mr. Monckton, representing Section C, drew attention to the labours of two committees wishing to obtain the co-operation of the corresponding societies in their work, the Geological Photographs Committee and the Erratic Blocks Committee. The secretary of the Geological Photographs Committee was Prof. W. W. Watts; the secretary of the Erratic Blocks Committee Prof. P. F. Kendall.

Section D.—The Rev. E. P. Knubley, representing Section D, was anxious that the corresponding societies should go on observing the migration of birds; also the food-supply of birds and the life-histories of insects.

Section H.—Mr. E. Sidney Hartland, representing Section H, brought before the Conference the work of the Anthropological Photographs Committee. That committee wished to collect photographs of objects of anthropological interest which were now scattered over the country, and almost unknown outside their own localities. They wanted photographs of prehistoric stone monuments and implements, of primitive pottery and of objects connected with local superstitions. The collection would be placed in the rooms of the Anthropological Institute. The secretary of the committee was Mr. J. L. Myres.

The Rev. J. O. Bevan urged the committees of the corresponding societies to lay before their members the desirability of a systematic survey of their counties with respect to their ethnography and ethnology, archæology, folklore, meteorology, botany, ornithology, &c. This kind of work was being done in part at various places. The committee of the British Association which had been concerned with ethnography and ethnology had been dissolved at the Dover meeting. He hoped that the local societies would take up the work, and inform the Corresponding Societies Committee what was being done.

After a few remarks from Mr. Hembry, who suggested that at future meetings sectional matters should be taken before the reading of a paper on any special subject, the meeting came to an end.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor announces that Mr. W. W. Astor has contributed the sum of £10,000 to the University Benefaction Fund.

Mr. F. G. Kenyon, assistant keeper of the manuscripts in the British Museum, has been appointed Sandars Reader in bibliography.

Dr. Haddon, F.R.S., has been appointed University lecturer in ethnology, and Mr. J. J. Lister, F.R.S., to be demonstrator of comparative anatomy.

A University lectureship in experimental physics is vacant by the resignation of Prof. Wilberforce. Applications should reach the Vice-Chancellor by Saturday, November 3.

The portrait of Charles Darwin, now in the Philosophical Library, has been lent for the exhibition of the works of Sir W. B. Richmond, to be held in the New Gallery.

MR. J. A. MCCLELLAND, M.A., has been appointed to the chair of Natural Philosophy in the University College, Dublin, which was rendered vacant by the death of Prof. Preston. Mr. McClelland is a native of North Ireland, and studied physics under Prof. Anderson at Queen's College, Galway. After graduating M.A., he went to Cambridge and continued his studies in physics under Prof. J. J. Thomson, obtaining the B.A. (Research) degree for his original work in the Cavendish Laboratory. In Ireland Mr. McClelland gained an "1837 Exhibition" Science Scholarship, and later a Junior Fellowship of the Royal University of Ireland.

A NOTEWORTHY announcement in the Calendar of University College, Bristol, is that a clinical and bacteriological research laboratory has been established at the college, under the direction of Prof. A. F. Stanley Kent. The value of such a laboratory in a port like that of Bristol cannot be over-estimated, and the City authorities should show their appreciation of it in a practical way. The laboratory will not only provide a means of obtaining trustworthy information and reports upon pathological material, but will also give medical men an opportunity of carrying out bacteriological investigations. Should plague ever appear in Bristol, as it has done at Glasgow, the City authorities will know the value of the laboratory now established at their University College. At present the college does not receive nearly so much local support as some of the other provincial colleges, and there seems to be little hope that there will ever be a West of England University with its centre at Bristol, analogous to the University of Birmingham.

IN the course of her able and suggestive address at the opening of the Passmore Edwards Museum of the Essex Field Club on October 18, the Countess of Warwick made the following statement with respect to local museums:—"I am convinced that museums are destined to play such an important part in education in the future that no town of any importance will be able to be without an institution of this kind. But one of the chief reasons why this part of the club's work has not hitherto been practically realised is because the establishment and maintenance of a museum requires considerable financial resources. However zealous the members of a county natural history society may be, their aims and objects rarely rouse popular enthusiasm to the extent of raising an adequate fund for such purposes. In some counties private munificence had compensated for the lack of public interest. In other cases—and I am glad to be able to quote as an example another Essex town, Colchester—an enlightened Town Council has enabled a local museum to find an appropriate home. And again, in other instances, some of the County Councils have given financial aid from the Technical Instruction Grant, quite a legitimate expenditure as it appears to me, and, if I may express a personal opinion, a most valuable way of assisting in the spread of that knowledge which is the core an essence of all sound scientific education—a knowledge of nature at first hand as distinguished from the knowledge imparted through books or didactically taught in the class-room. But I am afraid that we as a nation have hardly yet risen to that high-water mark of scientific culture which should characterise a great civilisation. I do not mean to imply that we are lacking in scientific ability, that we are devoid of originality, or that we have failed to contribute our share of knowledge to the sum total of human progress. But I fear that the *spirit of modern science* has not sunk into the public mind—it has not permeated the rank and file to that extent which is required by the age in which we live, the century of science *par excellence.* Our purses are ever open, and have always been opened, in the names of charity and philanthropy, religious endowment and missionary enterprise, political organisation and popular sports. But science, upon which the national welfare and our position in the scale of nations ultimately depends, has to go begging for her tens, while thousands are forthcoming for these other objects." These remarks, which were received with loud applause by the audience at West Ham to whom they were addressed, coming from the mouth of a lady who has set such a brilliant example by her pioneering work in rural education, should be productive of good throughout the country. Most cordially will our readers endorse Lady Warwick's sentiments.

SCIENTIFIC SERIALS.

THE *Journal of the Royal Microscopical Society* for October contains a further instalment of Mr. F. W. Millett's paper on recent Foraminifera of the Malay Archipelago; a short article on a new projection eye-piece and an improved polarising eye-piece, by Mr. E. B. Stringer; and the conclusion of Mr. E. M. Nelson's note on the microscopes of Powell, Ross, and Smith, the present instalment dealing with the instruments of

Smith and Beck (now Messrs. R. and J. Beck, Ltd.). In the summary of recent researches in microscopy is an interesting description (with illustrations) of a microscope, with its oculars and objectives, used by Prof. Amici, the discoverer in 1841 of the part played by the pollen-tube in the fertilisation of flowering plants. Nothing could more forcibly illustrate the enormous advance made during the past sixty years in the manufacture of the microscope and its appliances.

Bollettino della Società Sismologica Italiana, vol. vi. 1900–1901, Nos. 2 and 3.—On the necessity and on the choice of comparable seismic apparatus, by A. Cancani (see pp. 395–6).—On the velocity of propagation of the Emilian earthquake of March 4, 1898, by G. Agamennone. The velocity is found to be about 3 km. per second, and it does not vary perceptibly with the distance from the epicentre.—Contribution to the study of the great Neapolitan earthquake of December 1857, by L. Antonio. Contains a copy of a letter written from Caggiano, close to the position assigned by Mallet to the epicentre.—New type of seismometrograph, by G. Agamennone. A reprint of a paper describing an instrument specially designed for registering the very small movements of the ground.—Notices of earthquakes recorded in Italy (March 21 to June 5, 1899), by A. Cancani, the most important being the Greek earthquakes of April 6, 15 and May 3, the Dalmatian earthquake of May 15, and distant earthquakes on March 3, April 2, 12, 13, 16, May 8 and June 5.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"On the Capacity for Heat of Water between the Freezing and Boiling Points, together with a Determination of the Mechanical Equivalent of Heat in Terms of the International Electrical Units." Experiments by the Continuous-flow Method of Calorimetry performed in the Macdonald Physical Laboratory of McGill University, Montreal. By Howard Turner Barnes, M.A.Sc., D.Sc., Joule Student. Communicated by Prof. H. L. Callendar, F.R.S.

At the Toronto meeting of the British Association in 1897, a new method of calorimetry was proposed by Prof. Callendar and the author for the determination of the specific heat of a liquid in terms of the international electrical units. At the Dover meeting in September, 1899, some of the general results obtained with the method for water over a part of the range between 0° and 100° were communicated, with a general discussion of the bearing of the experiments to the work of other observers. In the present paper the author gives a summary of the complete work, in the case of water, to determine the thermal capacity at different temperatures between the freezing and boiling points.

Theory of the Method.

If a continuous flow of liquid in a tube be made to carry off a continuously supplied quantity of heat EC, in electrical units, then after all temperature conditions have become steady

$$JsQ(\theta_1 - \theta_0)t + (\theta_1 - \theta_0)ht = ECt$$

where

J = mechanical equivalent of heat,
Q = flow of liquid per second,
s = the specific heat of the liquid,
θ_0 = the temperature of the liquid flowing into the tube,
θ_1 = the temperature of the liquid flowing out of the tube,
h = the heat loss per degree rise of temperature from the liquid flowing through,
t = the time of flow.

In the case of water, E represents the E.M.F. across an electrical heating conductor in the tube, and C the current flowing. In this case, which is treated of entirely in the present paper, Js is replaced by $4{\cdot}2\,(1 \pm \delta)$ where δ is a small quantity to be determined, and varies with the thermal capacity of the water, which is not exactly equal to 4·2 joules at all points of the range.

Substituting in the general equation, rearranging terms, and dividing through by t, the equation is given in the following form:—

$$4{\cdot}2Q(\theta_1 - \theta_0)\delta + (\theta_1 - \theta_0)h = EC - 4{\cdot}2Q(\theta_1 - \theta_0),$$

which is termed the general difference equation of the method. The two terms δ and h may be determined by using two values of Q, giving two equations of the form

$$4{\cdot}2Q_1(\theta_1 + \theta_0)\delta_1 + (\theta_1 - \theta_0)h = E_1C_1 - 4{\cdot}2Q_1(\theta_1 - \theta_0)$$
$$4{\cdot}2Q_2(\theta_2 - \theta_0)\delta_2 + (\theta_2 - \theta_0)h = E_2C_2 - 4{\cdot}2Q_2(\theta_2 - \theta_0).$$

For the same value of θ_0, if the electrical supply for the two flows is regulated so that $\theta_1 = \theta_2$, then $\delta_1 = \delta_2 = \delta$, and by eliminating h,

$$\delta = \frac{(E_1C_1 - 4{\cdot}2Q_1(\theta_1 - \theta_0)) - (E_2C_2 - 4{\cdot}2Q_2(\theta_1 - \theta_0))}{4{\cdot}2(Q_1 - Q_2)(\theta_1 - \theta_0)}$$

which corresponds to the mean temperature

$$\theta_0 + \frac{\theta_1 - \theta_0}{2},$$

where $(\theta_1 - \theta_0)$ is not too great.

In the present method the flow tube is of glass, about 2 mm. in diameter, connected to two larger tubes forming an inflow and an outflow tube, in which the temperature of the water is read, by a differential pair of platinum thermometers, before and after being heated by the electric current. A glass vacuum jacket surrounds the fine flow tube and a part of the inflow and outflow tubes, to reduce the heat loss as much as possible. A copper water jacket encloses the inflow tubes and vacuum jacket, in order to maintain the glass surface of the vacuum jacket always at a constant temperature equal to the inflowing water. The heat loss from the water is then the loss due to radiation from the flow tube through the vacuum jacket, and conduction from the ends of the flow tubes.

In testing the accuracy of the method, the dependence of the heat loss on the rise of temperature was found, and the dependence of the heat loss on the flow.

The results with different calorimeters and with different rises of temperature are given in the following table:—

Summary of the Specific Heat of Water from Smoothed Curve.

Temperature C.	δ	J.
5	+0·00250	4·2105
10	−0·00050	4·1979
15	−0·00250	4·1895
20	−0·00385	4·1838
25	−0·00474	4·1801
30	−0·00523	4·1780
35	−0·00545	4·1773
40	−0·00545	4·1773
45	−0·00520	4·1782
50	−0·00480	4·1798
55	−0·00430	4·1819
60	−0·00370	4·1845
65	−0·00310	4·1870
70	−0·00245	4·1898
75	−0·00180	4·1925
80	−0·00114	4·1954
85	−0·00043	4·1982
90	+0·00025	4·2010
95	+0·00090	4·2038
	Mean value	4·18876

The values of δ represent the specific heat of water in terms of a thermal unit equal to 4·2000 joules, which occurs at 9° C. It is more suitable to select a thermal unit at a more convenient part of the scale. The mean value of the mechanical equivalent of heat from these measurements over the whole range is 4·18876 joules, which is very nearly equal to the value at 16° C., which is 4·1883 joules. It seems desirable to select a unit at a temperature which, if at the same time at a convenient part of the scale, may be equal to the mean value over the whole scale. The author has in consequence adopted a unit at 16° C., and has expressed the specific heat of water in terms of this unit.

Two formulæ can be fitted very accurately over the scale. Between 5° and 37·5° C. the following expression in terms of a thermal unit at 16° is found to read,

$$S = 0{\cdot}99733 + 0{\cdot}0000035(37{\cdot}5 - t)^2 + 0{\cdot}00000010(37{\cdot}5 - t^3).$$

The same formula holds between 37·5° and 55° by simply considering all values of the cubical term positive. Above 55° the simple formula

$$S = 0{\cdot}99850 + 0{\cdot}000120(t - 55^\circ) + 0{\cdot}00000025(t - 55)^2$$

holds with great accuracy.

Physical Society, October 26.—Dr. Lodge, President, in the chair.—The chairman read a letter from Prof. Cleveland Abbe, of the United States Coast and Geodetic Survey, stating that the *Monthly Weather Review* would be sent regularly to any member of the Physical Society expressing a wish to receive

it. On the other hand, the Chief of the Weather Bureau would at any time be glad to receive communications referring to the physics of the atmosphere.—Dr. Shelford Bidwell then exhibited some experiments illustrating phenomena of vision. The first phenomenon illustrated was that known as "Recurrent Vision." A vacuum tube, illuminated by an induction coil, was made to rotate about a horizontal axis, and was seen to be followed, at an angle of about forty degrees, by a feebly luminous reproduction of itself. A spot of white light, projected upon a screen, and caused to move slowly in a circular path, was also followed by a less luminous spot. The same effect was shown by spots of green and yellow light, but in the case of red light no ghost was visible. The phenomena of recurrent vision are due principally, if not entirely, to the action of violet nerve fibres. The next experiments related to the non-achromatism of the eye. The lenses of the eye do not constitute an achromatic combination, although under ordinary conditions a bright object is not surrounded by fringes of colour. The effects of chromatic aberration are disguised by the luminous haze which surrounds the object, produced by a defect in the eye regarded as an optical instrument. A six-rayed star, formed by cutting a hole in an opaque screen, was illuminated by a gauze-covered condenser containing an incandescent lamp. The star was fairly clearly defined, and there were no fringes. More attentive observation showed a luminous haze. This haze is formed in consequence of the cellular structure of the eye, and the brightest rays—orange, yellow and green—are chiefly instrumental in forming it. If, therefore, these rays are obstructed, the conditions are more favourable for the observation of chromatic aberration. The rays were consequently cut off by means of coloured glasses, and the general hue of the star was purple; to some it appeared bordered with dark blue, while to others (long-sighted) it appeared bordered with red. Two oblong patches, one red and the other blue-violet, and of approximately the same intensity, were then produced side by side upon a screen. An observer with very good eyesight was able, at a distance of ten feet, to focus the patches alternately with perfect distinctness. In general, the blue patch was said to be more or less blurred. With an achromatic eye it should be possible to focus both together. Dr. Bidwell then showed some lantern slides, illustrating the complex form seen when viewing a small luminous spot through a gauze-covered lens placed so as not to be in exact focus. Some experiments were performed illustrating the principle of the colour top. When a bright image is formed on the retina after a period of darkness it has, in general, a red border which lasts for a fraction of a second. A dark patch suddenly formed on a bright ground has a blue border which lasts for a similar time. These effects were attributed by Dr. Bidwell to a sympathetic action of the red nerve fibres. When the various nerve fibres occupying a limited portion of the retina are stimulated by ordinary white or yellow light, the immediately surrounding red nerve fibres are for a short period excited sympathetically, while the violet or blue and green fibres are not so excited, or in a much less degree. Again, when light is suddenly cut off from a patch in a bright field, there occurs a sympathetic insensitive reaction in the red fibres just outside the darkened patch, in virtue of which they cease for a moment to respond to the luminous stimulus; the green and violet fibres by continuing to respond uninterruptedly give rise to the sensation of a blue border. By a simple experiment it was shown that the explanation of the colour top, depending upon changes in the convexity of the eye and non-achromatism, was untenable. By the use of a strong light it is possible to get negative after-images after looking at a brightly-coloured object. These images are complementary in colour to the object, and are formed even if the object is only viewed for a fraction of a second. By means of proper illumination and a disc rotating at the proper speed, a red wafer was so arranged that, upon looking at it, it was impossible to recognise the wafer itself, but only the continuous green after-image. The Chairman expressed his interest in the last experiment, in which it was possible to see the negative after-image of an object and not the object itself. Prof. S. P. Thompson said these experiments threw a doubt on some of the accepted notions about the properties of the eye. Dr. Bidwell asks us to believe that the yellow haze is due to a cellular structure in the eye. Is there such a structure? Can it be observed with a microscope? And do its meshes correspond in magnitude with those necessary to produce the effects? By diminishing the size of the pupil the haze is diminished and the sharpness of the image is increased. The effects seem to be due to ordinary aberration. Prof. Thompson said that the achromatism of the eye was simply shown by covering half the object-glass of a telescope and viewing a bright object with it. The object then seems bordered with coloured fringes. Mr. Blakesley, referring to the colour patches used by Dr. Bidwell, pointed out that although the patches were the same distance from the lens, yet they did not possess the same magnification. The last experiment shown did away with the theory of persistence of vision, because the space between the object and the negative after-image was evidently not illuminated. Mr. Trotter asked if red and green were the only colours which gave complementary negative after-images. Dr. Bidwell, in reply, said the effect was obtainable throughout the length of the spectrum.—A paper on the concentration at the electrodes in a solution, with special reference to the liberation of hydrogen by electrolysis of a mixture of copper sulphate and sulphuric acid, was read by Dr. H. J. S. Sand. In this paper an equation has been derived for calculating the concentration at the electrode of a solution of a single salt from which the metal is being deposited under the conditions (1) that the solution is contained in a cylindrical vessel bounded by the electrodes, (2) that no convection-currents occur, and (3) that the diffusion of the salt obeys Fick's law, and its transport values are constant. This formula can be made the basis for roughly determining diffusion coefficients. In the case of mixtures, it is possible to arrive at limits for the concentration, and it has been experimentally proved that hydrogen always appears at the electrode of an acid solution of copper sulphate, in which no currents of liquid are taking place, between the limits of time for the concentration to go down to zero. The time which it takes for the hydrogen to appear can be calculated from an empirical formula, which is similar in form to the one used for a single salt. The great part played by convection-currents in determining the ratio of the two constituents given off at the electrode of an acid copper-sulphate solution, has been shown by proving experimentally that artificial stirring causes hydrogen to disappear altogether in cases where it would otherwise have presented over sixty per cent. of the equivalents carrying the current from the solution to the electrode. The Chairman drew attention to the fact that no hydrogen was liberated until all the copper had gone, and said the formula for the concentration might be used again in further investigations. Dr. Donnan asked if the time at which hydrogen was liberated had been taken as the time at which hydrogen actually made its appearance in the form of bubbles, or whether any allowance had been made for saturation. Dr. Sand said the time was taken up to the appearance of bubbles.—A paper by Dr. R. A. Lehfeldt on electromotive force and osmotic pressure was postponed until the next meeting. The meeting then adjourned until November 9.

PARIS.

Academy of Sciences, October 22.—M. Maurice Lévy in the chair.—On the convergence of meridians, by M. Hatt.—Diagnosis of gaseous supersaturation in cases of a physical order and chemical order, by M. Berthelot. A description is given of attempts made to distinguish between these two classes of phenomena by means of the calorimeter, the reactions studied being the decomposition of dilute solutions of hydrogen peroxide by addition of platinum black or of potassium permanganate. From experiments with the latter reagent, the conclusion is drawn that the considerable quantities of oxygen held in solution are held in the state of an unstable chemical compound.—The origin of atmospheric hydrogen, by M. Armand Gautier. It has been shown in previous papers that air normally contains about ·02 per cent. of free hydrogen. It has been shown that, besides being a normal product of some putrefactive fermentations, hydrogen is given off by many volcanoes, and also escapes from many mineral springs. It is found that certain granites treated *in vacuo* with phosphoric acid give about from three to four times their volume of free hydrogen. Since ammonia is always produced at the same time, the surmise is put forward that nitride of iron, Fe_6N_2, is the source of these two gases. This nitride has not been isolated from these granites, but iron nitrides have been found in the crystalline deposits of the lava fissures of Etna by Silvestri.—Observations on the development of the Onychophoræ, by M. E. L. Bouvier. The species, *Peripatopsis Sedgwicki*, is distinguished from other species of the same genus by the nutritive blastodermic vessicle on the head of its embryos, and by the different stages of the embryo found in the same female,

These facts have already been shortly noticed, but fuller details are given in the present paper.—On the topographical correction of pendulum observations, by M. J. Callet. The method suggested has been worked out for two stations, La Bérarde and Lautaret, situated in the centre of the Alps. The application of the corrections is tedious and lengthy, but the errors of the results obtained are of the same order as those inherent in the pendulum observations themselves under favourable conditions.—Observations of the Perseids, made at Athens, by M. D. Eginitis. The observations were carried out between August 5 and August 12. The meteors were of a reddish-yellow colour, of about the 5th magnitude, and possessed a large number of radiant points.—First results of researches on the recognition of the solar corona at other times than during a total eclipse by means of the calorific rays, by M. H. Deslandres. The possibility of detecting the corona with the aid of a thermo-couple having been proved during the recent total eclipse, daily observations with the same apparatus have since then been carried out at Meudon. The results, although incomplete, show that the presence of the corona can be clearly detected under ordinary conditions in this way. The observations will be continued with more sensitive apparatus.—On the convergence of the coefficients in the development of the perturbation function, by M. A. Féraud.—On the intrinsic equations of motion of a wire, and the calculation of its tension, by M. G. Floquet.—On orthogonal systems admitting a continuous group of transformations of Combescure, by M. D. Th. Egorou.—Index of refraction of bromine, by M. Ch. Rivière. The index of refraction of carefully purified bromine has been determined for temperatures between 10° and 25° for wave-lengths between 790·9 $\mu\mu$ and 592·5 $\mu\mu$, and show that bromine has very great dispersive power, that for rays between A and D at 20° being ·037, compared with ·030 for carbon bisulphide.—The law of moduli. Thermochemical moduli, by M. A. Ponsot.—On the ammoniacal arseniates of cobalt, by M. O. Ducru. The existence of three distinct salts is indicated, which can be distinguished by the pressures at which ammonia commences to be given off.—On a general method of preparation of mixed carbonates of phenols and alcohols, and on the properties of some of these esters, by M. E. Barral. Of the various methods proposed for the preparation of these mixed esters, the best results are obtained by the action of carbonyl chloride upon a solution of the phenol in alcoholic potash or soda, the reagents being all employed in molecular proportions.—Stereochemistry of nitrogen. The stereoisomeric hydrazones of ethyl pyruvate, by M. L. J. Simon. The two isomeric hydrazones are obtained simultaneously, but in unequal quantities. They differ considerably in melting points and solubilities.—Acetals of monovalent alcohols, by M. Marcel Delépine. A thermochemical paper.—On direct nitration in the fatty series, by MM. L. Boauveault and Wahl.—Partial synthesis of laudanosine, by MM. Amé Pictet and B. Athanesesco.—On the pollinisation of cleistogamous flowers, by M. Leclerc du Sablon.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 1.

CHEMICAL SOCIETY, at 8.—Dehydrohomocamphoric Acid and its Oxidation Products: Arthur Lapworth.—Derivatives of Ethyl α-methyl-β-phenylcyanglutarate: W. Carter and W. Trevor Lawrence.—The Nitration of Acetamino-*o*-phenylacetate (diacetyl-*o*-aminophenol)—a Correction: R. Meldola, F.R.S.; and Elkan Wechsler.—Rhamnazin and Rhamnetin: A. G. Perkin and J. R. Allison.—(1) Luteolin, Part III.; (2) Genistein, Part II.: A. G. Perkin and L. H. Horsfall.—Colouring Matter of the Flowers of *Delphinium consolida*: A. G. Perkin and E. J. Wilkinson.—The Action of Alkalis on the Nitro-compounds of the Paraffin Series, Part II.: Wyndham R. Dunstan, F.R.S., and Ernest Goulding.—Hexachlorides of Benzonitrile, Benzamide and Benzoic Acid: F. E. Matthews.—The Influence of Solvents on the Rotation of Optically-active Compounds, Part I.: T. S. Patterson.—Note on Gallinek's Amidomethylnaphthimidazole: R. Meldola, F.R.S., and F. H. Streatfeild.—The Action of Heat on Ethyl-Sulphuric Acid: W. Ramsay and G. Rudorf.—The Amount of Chlorine in Rain-water collected at Cirencester: Edward Kinch.

RÖNTGEN SOCIETY, at 8.—Presidential Address: Dr. J. B. Macintyre.

FRIDAY, NOVEMBER 2.

GEOLOGISTS' ASSOCIATION, at 8.—Conversazione, with Exhibits of Objects and Photographs.

MONDAY, NOVEMBER 5.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Preliminary Examination of Applications for Patents: W. Lloyd Wise.—The Early Manufacture of Sulphuric and Nitric Acids: Oscar Guttmann.

TUESDAY, NOVEMBER 6.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by the President, Mr. James Mansergh, and presentation of medals and prizes awarded by the Council.

WEDNESDAY, NOVEMBER 7.

GEOLOGICAL SOCIETY, at 8.—Additional Notes on the Drifts of the Baltic Coast of Germany: Prof. T. G. Bonney, F.R.S., and the Rev. Edwin Hill.—On certain Altered Rocks from near Bastogne, and their Relations to others in the District: Dr. Catherine A. Raisin.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Determination of the Available Brewing Extract of Malt: Lawrence Briant.—The Definition of the Genuine Product: C. E. Cassal.—Notes on certain B.P. Tests: C. G. Moor and Martin Priest.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 8.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—On the Transmission of Force through a Solid: Lord Kelvin, G.C.V.O.—In a Simple Group of an Odd Composite Order every System of Conjugate Operators or Sub-groups includes more than Fifty: Dr. G. A. Miller.—Prime Functions on a Riemann Surface: Prof. A. C. Dixon. (i) Further Note on Isoscelians; (ii) On Two In-triangles which are similar to the Pedal Triangle: R. Tucker.—(i) A General Congruence Theorem relating to the Bernoullian Function; (ii) On the Residues of Bernoullian Functions for a Prime Modulus, including as Special Cases the Residues of the Eulerian Numbers and the I-numbers: Dr. Glaisher, F.R.S.—On Green's Function for a Circular Disc: H. S. Carslaw.—On the Real Points of Inflexion of a Curve: A. B. Basset, F.R.S.—On Quantitative Substitutional Analysis: A. Young.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address: Prof. J. Perry, F.R.S.

FRIDAY, NOVEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 8.

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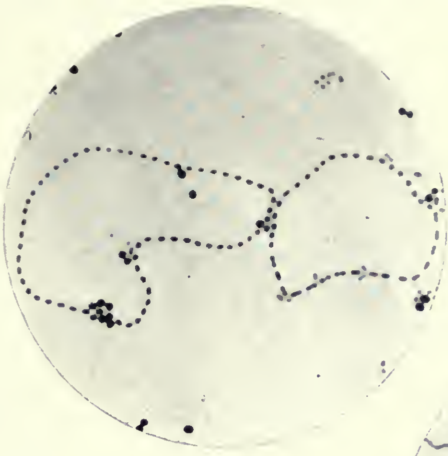

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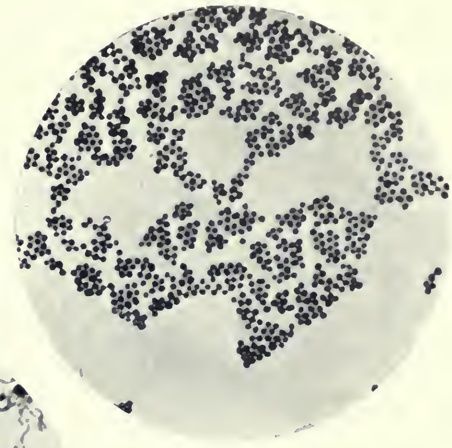

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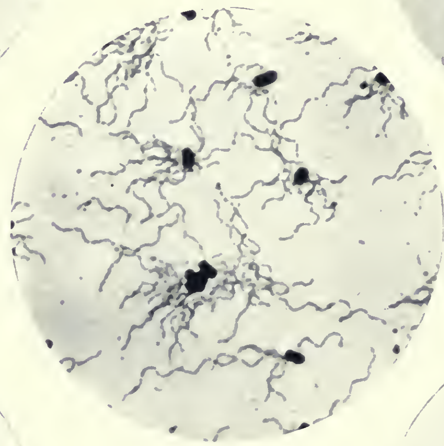

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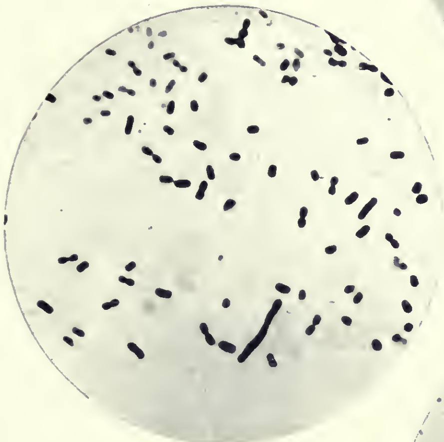

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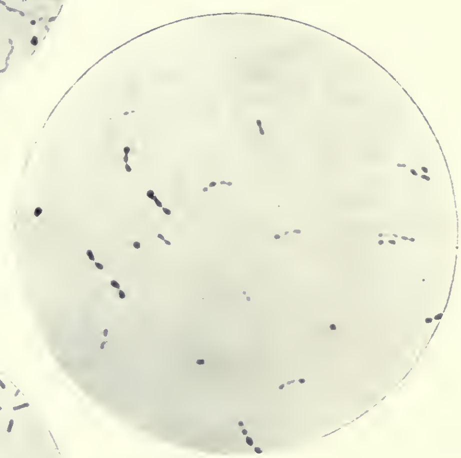

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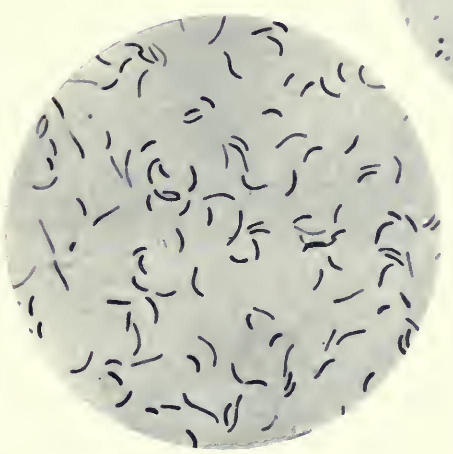


Fig. 5

Fig. 6

PHOTO-MICROGRAPHS TAKEN AT THE JENNER INSTITUTE OF PREVENTIVE MEDICINE TO ACCOMPANY ARTICLE BY DR. A. MACFADYEN AND J. E. BARNARD

THURSDAY, NOVEMBER 8, 1900.

SCIENCE AND PSEUDO-SCIENCE.

Genèse de la Matière et de l'Energie—Formation et Fin d'un Monde. Par A. Despaux, Ingénieur des Arts et Manufactures. Pp. 232. (Paris: Félix Alcan, 1900.)

THERE are two classes of writers whose works on scientific subjects possess little or no intrinsic scientific value. The first consists of those who, carrying their distrust of rational authority even beyond the bounds of sanity, run headlong against established modes of thought, and lose themselves in a maze of paradox. To the second class belong authors who, while they show no outward disrespect for the accepted elements of orthodox philosophy, have neither the patience nor the ability to pursue the arduous paths which lead to truth, but with a courage born of want of knowledge of the real difficulties take their own way under the treacherous guidance of blind intuition.

The rapidity of their progress is astonishing, but whether it has an end worth reaching may in general be questioned. The cautious critic finds these excursions difficult to follow, and he therefore has a natural tendency perhaps to do them less than justice. But it may be proper to insist here on the fact that it is of little use even to blunder on a truth unless care be taken to free it from all that is doubtful, and to place it in a convincing light. Failure in this respect constitutes a serious objection to the intuitive method as exemplified by the book under review.

To the representatives of intuitive as opposed to more scientific methods the borderland of the known in science offers great opportunities. In particular, the problems of cosmogony and molecular physics seem to possess a singular fascination for this type of mind. It seems to matter little that these problems present the very greatest difficulties, of which the mere exact formulation is not to be undertaken lightly, and which seem to demand for their solution a mastery over so wide a range of experimental fact and so great a power in the use of mathematical analysis as to have baffled hitherto the most gifted investigators. Indeed, it is being realised more and more how inadequate is the store of facts and how great the need, probably, of an entirely new machinery of analysis. And yet how petty are our discussions, for instance, of the propriety of employing the principle of Action, how futile our doubts about the appropriateness of certain mechanical models to represent ethereal operations! Our intuitive philosophers, as we have said, are ready at one bound to surmount such pedantic obstacles, and why should we not follow them?

The mere title of this book seems to give some justification for suspecting that M. Despaux is not quite innocent of those heretical methods to which we have alluded. Within the modest compass of 232 octavo pages he attempts to explain the origin and nature of matter and energy, the constitution of the molecule, gravitation, many fundamental questions in physics, such as radiant energy and electricity, and, in addition to all this, the formation of the solar system. The scheme is so ambitious that the conclusion seems inevitable that the author has failed to realise the stupendous difficulties to be overcome. And this impression, which is fully confirmed on reading his book, makes it impossible to consider it very seriously. The phenomena to which the author refers are only such as must be well known even to the most elementary student of physics, and if M. Despaux has any claims to be considered a mathematician, his modesty has led him to conceal the fact most scrupulously.

The reader of the book quickly finds that in order to follow the author closely he must gain some idea of M. Despaux' views on the nature of the ether and of the atom. The former he considers as the vehicle necessary for the transference of energy in an undulatory form. Up to a certain point his notions of wave motion are clear and well expressed. Unfortunately, they are as restricted as those of a century ago, and are in effect confined to waves of the condensational-rarefractional type. The result is that the author describes the ether as a discontinuous medium, possessing in some measure the qualities of a gas, thus ignoring all the difficulties which arise from the phenomena of polarisation. On the other hand, his general views on the meaning of action at a distance, and on the ether as the true energy medium, are much more satisfactory and consistent with modern ideas. It is more difficult to follow M. Despaux' suggestions as to the nature of the atom. We gather that there is an essential unity between all kinds of matter, and that all atoms are intrinsically alike. They are the seat of kinetic energy, and appear to be differentiated only by their particular modes of motion. The energy gives rise to vibrations of two types of which one becomes apparent in the form of radiant energy, while the other causes the effect of mutual gravitation and chemical affinity. But lest we should misrepresent his thoughts, we may quote M. Despaux' own words—

"La gravitation est due à la rotation hélicoïdale des atomes ou molécules qui produit une translation dans l'éther; sans rotation, pas de gravité, les corps seraient sans poids, sans chaleur, sans couleur, . . . Ce qui caractérise la matière, c'est en effet le mouvement des atomes bien plus que les atomes eux-mêmes centres de ces mouvements. . . . En résumé, contrairement aux idées reçues, nous estimons que la masse d'un corps dépend moins du nombre des molécules que de leur vitesse de rotation.—Toutes les energies mettant en jeu les attractions et les répulsions sont de même nature que la gravitation" (pp. 94, 95).

Now the implied connection between gravitation and heat is as repugnant to our ideas as the caloric theory of heat itself; for the former involves an identification o mass with energy which is as objectionable as the confusion of a form of energy with matter in the latter. The grounds of objection are, in fact, precisely the same in both cases. The origin of the heresy is to be found in M. Despaux' incapacity to realise the meaning of mass as a distinct entity. He professes carefully to eschew all arguments which appear to him of a metaphysical nature, and yet fails to see that the discussion of fundamental physical conceptions really belongs to the domain of metaphysics. It is distinctly a pity that he has virtually exceeded the limits of his purpose, for his qualifications as a philosopher seem to be inferior even to his equipment as a physicist.

It seems idle to pursue the author further in his speculations. Not content with formulating a theory of the operation of nature on the molecular scale, he devotes the last part of his essay to the exposition of his views on the subject of cosmogony. In this he adopts the nebular theory of Laplace as a general scheme, and applies to it the ideas which he has previously developed. He has an explanation to offer of the cases of retrograde motion in the solar system and of other phenomena which have been thought to present difficulties. On these points he apparently satisfies himself, though others, in the absence of rigorous proof, may remain sceptical. It is in reference to a subject of some debate, the ultimate fate of the solar system, in fact, that he offers a novel suggestion, based on his peculiar conception of the atom. As others have supposed, the end must come with the slow dissipation of energy; but, in the system of M. Despaux, this implies the loss, not only of heat, but also of gravitational power in the atom, or, in other words, of weight. The energy passes to the ether, and matter deprived of its chief property becomes immaterial. The world, then, no longer remains as an inert mass, but reaches its dissolution and leaves "not a rack behind." It is true that M. Despaux contemplates a return of the energy to the atom, and the whole process from the birth to the death of the system repeated in an endless cycle. But even he does not venture to describe in any detail how this is to come about.

Enough has been said as to the scope of this book, and some reason has been assigned for considering it unphilosophical in design and unenlightened in execution. But it is not to be thought that the author is an unfavourable example of the class to which he belongs. He expresses clearly and concisely what he has to say; he is respectful to the great workers who have adhered to the recognised laborious paths; and it should not be thought that there are no ideas to be found in his work which are true, though such as are true may generally appear not to be original. Yet, when all that is said, it is difficult to conceive the utility of such a work.

A NEW TEXT-BOOK ON SOUND.

A Text-Book of Physics. Sound. By J. H. Poynting, Sc.D., F.R.S., and J. J. Thomson, M.A., F.R.S., Hon. Sc.D. (Dublin), Hon. D.L. (Princeton). Pp. x + 163. (London: Chas. Griffin and Co., Ltd., 1899.)

THIS volume will be welcomed by those interested in the teaching of physical science, not only on account of its individual merits, but also as the first instalment of a complete treatise on physics now in preparation by the authors. It is intended for the use of students who lay most stress on the study of the experimental part of physics, and who have not yet reached the stage at which the reading of advanced treatises on special subjects is desirable. For this class of students it is important that the mathematics used should be of the simplest. So far as concerns those who are unacquainted with the calculus, this is self-evident; it is, further, none the less true with regard to those possessing some knowledge of the higher mathematics. Unless great care is exercised, the use of the calculus is apt to become so far mechanical that the student may possibly miss many tacit assumptions which it would be advantageous for him to clearly recognise. To all students it is alike of importance that each stage in the reasoning employed should be brought into view as clearly as possible, and subjected to the most searching scrutiny. This can be done, sometimes by the use of comparatively simple analytical and geometrical devices, often by the application of the principles of the calculus developed *ab initio.* The volume under consideration comprises many most successful attempts to apply simple mathematical methods to the solution of important, and sometimes fairly intricate, problems. The investigation of the modes of vibration of a stretched string, on pp. 86–88, is perhaps the least successful effort in this direction; few students would, it may be feared, be able to keep the essential features of the problem clearly distinguished from the number of geometrical and analytical assumptions and approximations involved. The investigation of the same problem from another standpoint, as given on p. 93, is much to be preferred in this respect.

In the first chapter a good account is given of the general nature and characteristics of sound. A simple experiment, due to Prof. Boys, in which the vibratory character of sound in air is made manifest, might perhaps have been mentioned with advantage. A Bunsen flame is burnt near the end of an open organ pipe, and when the latter is sounded the sinusoidal paths of dust particles traversing the flame are readily seen. From a mathematical point of view, it is to be regretted that a solution is not here given of the problem of the motion of a heavy particle, attracted toward a point with a force proportional to its displacement therefrom. If we suppose the particle to revolve in a circular orbit about the point, then it is easily seen that the centrifugal force must be equal to the central attraction exerted. Resolving the instantaneous displacement, velocity and central force parallel and perpendicularly to any given axis, then we have two harmonic motions executed under the actions of forces proportional to the displacement from the centre. Considering only one of these harmonic motions, the value of the kinetic and potential energies at any point may easily be written down, when it becomes evident that their sum is constant. Equating the potential energy at the extremity of an excursion to the kinetic energy at the point of equilibrium, the well-known expression for the time of vibration is readily obtained. It is interesting to note that this graphical solution corresponds to assigning the real part of $A\epsilon^{iat}$ as the value of x which satisfies the differential equation

$$\frac{d^2x}{dt^2} + a^2t = 0.$$

The second chapter commences with a simple theoretical investigation of the velocity of sound in a fluid, and is followed by an interesting and valuable account of the experimental aspect of the same question. In connection with the reflection of sound, the curious musical ring, often heard to follow each footfall when one is walking near palisading, is simply explained, and Lord Rayleigh's theory of whispering galleries is described. The introduction in ensuing editions of a few reproductions of Prof. Wood's photographs of sound waves would enhance the interest of this section. Refraction of sounds by winds and air-layers of different densities is also

described and explained. The third chapter is occupied with the frequency and pitch of notes, methods of determining the period of a tuning fork, Döppler's principle and musical scales. Whilst comprising little that is new, the account given should prove very useful to students. A short account of resonance and forced vibrations is given in the fourth chapter, whilst the succeeding chapter is occupied with the analysis of vibrations. The mathematical investigation on p. 66, concerning the superposition of harmonic curves, might advantageously have been given rather more in detail considering the class of students for whom the book is written ; but there are few other instances where this objection can be raised.

Chapter vi. is concerned with the vibrations of strings, and a very useful and systematic account of this part of the subject is given. This should prove very acceptable to students as leaving unexplained no point on which difficulties are likely to hang. The vibrations of air in pipes, and of rods, plates and membranes, are treated of in an equally satisfactory manner in Chapters vii. and viii.

One of the most interesting chapters in this volume is the ninth, devoted to singing flames, sensitive flames and jets, and musical sand. Lord Rayleigh's investigation of the conditions necessary for the production of a singing flame is clearly and simply explained, and many other phenomena dependent on similar principles are described. The description and explanation of the musical note, produced when certain sands are struck or otherwise disturbed, will doubtless be read with great interest.

Finally, it may be confidently predicted that this volume will meet with an appreciative reception from all serious students of physics. It is characterised throughout by the absence of obscure and inconclusive reasoning such as is sometimes found in treatises dealing with intricate problems in an elementary manner, by the employment of sound yet simple mathematical methods, and by the inclusion of accounts of recent work not to be found in other books of the same class. Many students might wish that examination questions had been added at the end of each chapter, and some may consider that sixty-six pages of advertisements at the end of the book somewhat exceed what might have been expected in this direction. Otherwise it would be difficult to find grounds for any sentiment but gratification that a gap in our scientific literature has been so worthily filled.

E. E.

GEOLOGY AND PRACTICE.

Steinbruchindustrie und Steinbruchgeologie: technische Geologie nebst praktischen Winken für die Verwertung von Gesteinen, unter eingehender Berücksichtigung der Steinindustrie des Königreiches Sachsen. By Dr. O. Herrmann. Pp. xvi + 428. (Berlin : Borntraeger, 1899.)

IN its elaborate title, of which we have omitted the concluding lines, this work explains its own existence. While it gives a useful account of methods of quarrying, and of the practical applications of various kinds of stone, it specially describes the rocks of Saxony and their economic relations at the present day. The two divisions, general and special, occupy almost equal space, and it will be seen that the book is thus a valuable addition to our libraries. What some of the American States have done for their own areas, what Mr. G. H. Kinahan did for Ireland, in his papers on "Economic Geology," is here repeated for a country of great geological interest. It appears that in Saxony, as in London itself, the use of stone for buildings of a permanent character is becoming more and more extensive, while increasing demands are made upon the quarries for ordinary engineering works.

Dr. Herrmann prefaces his book by an account of the more common rock-forming minerals, and of the rocks ordinarily quarried. This is said to be "zur Orientierung für Nicht-Geologen"; but naturally the elements of mineralogical knowledge are presupposed. A quarry-owner would not be expected to identify his minerals from the descriptions given here, but would doubtless have received, in his preliminary scientific training, a good foundation of chemistry and some practical acquaintance with the materials of the earth's crust. Dr. Herrmann therefore does well to emphasise, in his descriptions, the characters that give each mineral or rock its importance from a technical point of view. The lists of localities, reminding one of those in Roth's "Allgemeine Geologie," and references to the buildings where certain rocks have been employed, might, it seems, have been omitted from this section, in view of the forty-three pages devoted to this subject in a later portion of the work.

The author, writing as recently as 1899 (p. 53), places all the ordinary lavas, rhyolite, basalt, and so forth, as "Eruptivgesteine tertiären und nachtertiären Alters," a classification which is merely playing with words, and which has only a superficial justification in the field. His excuse must lie in the powerful continental combination in favour of an arrangement which, to Western minds, savoured too strongly of the Wernerian school ; its abandonment of late years may, indeed, mark the breaking down of the "mineral cabinet" system of geology, which the spread of microscopic research tended at one time to maintain.

The valuable section of the work (pp. 123–181) on the characters required in rocks selected for various industrial purposes, and on methods of extraction, is illustrated by photographs of actual quarries, taken by the author. We then pass to the special consideration of the application (Verwertung) of the rocks of Saxony to the technical requirements of the country. Many of these rocks are so well known to every student of geology that an account of their mode of occurrence, from a new point of view, is of scientific as well as industrial importance. We notice the tendency to introduce foreign stones side by side with those of some well-worked local quarry, the materials being cut and polished on the same spot. The natural demand for variety in the colour-scheme of our great city-buildings will often limit the demand for a local stone, however excellent, and "foreign competition" may be favoured by good taste as much as by a war of prices.

The account of the Serpentine of Zöblitz, which "has arisen from the alteration of a Lherzolite," is a good example of the interest attaching to the author's mode of treatment. His historical review extends back to the cutting of the stone by a herd-boy, as he watched his cattle, in the middle of the fifteenth century (p. 255).

As an illustration of the many details of geological

value that are probably to be found only in these pages, we may mention the statement (p. 235) that the pitchstones of Meissen are melted up, in increasing quantities, for producing bottle-glass, but that difficulties arise from the very ready formation of bubbles in the mass. This at once reminds us of the experiments of Berger, by which obsidians were converted into pumice before the blowpipe, and of Judd's far-reaching deductions in connection with the lavas of Krakatoa.

An appendix gives, in somewhat unnecessary detail, an account of the road-metal used on the Government roads of Saxony in 1896. The conclusion, however (p. 351), is worth quoting: "Thus, from the group of sandstones, limestones, dolomites, mica-schists, phyllites, slates, loams and clays, which together form 40 per cent. of the surface of Saxony, no material at all was selected for the construction of the roads, while only 1·94 per cent. of the total road-length was made of sands and gravels, which none the less cover great areas." This surprising fact may be commended to our county surveyors, especially in the limestone districts of Ireland. It is true that in France, with a magnificent system of steam-rolling and workmen's caravans, a good road can be made of limestone, if frequently examined and renewed; but the failure in such regions as the Côte d'Or plateaux, where the difficulties of our own Cotteswolds are encountered, shows how much lies in the choice of materials at the outset. Perhaps the eye for minerals, and the natural aptitude for their extraction, which have made Saxon miners the pioneers of Europe, have found expression also in the accurate choice of road-metal.

While Dr. Herrmann's work does not presume to rank as a general text-book, it should be added to our scientific and technical libraries, if only as a record of progress in a State where science is rightly regarded as the inspiring muse of industry. GRENVILLE A. J. COLE.

OUR BOOK SHELF.

Die Mathematik an den Deutschen technischen Hochschulen. Dr. Erwin Papperitz. (Leipzig: Veit, 1899.)
Ueber den Plan eines physikalisch-technischen Instituts an der Universität Göttingen. Felix Klein. (1895.)
Die Anforderungen der Ingenieure und die Ausbildung der mathematischen Lehramtskandidaten. Felix Klein. (1896.)

THESE pamphlets are interesting as showing that the revolutionary ideas brought forward by Prof. Perry on the teaching of mathematics have already begun to agitate the German academic mind; and that his ideas concerning the proper method of presenting the principles of the subject, having regard to the requirements of the student, will receive powerful support in Germany.

The cleavage now going on in mathematical thought was very evident in the recent Physical and Mathematical Congresses, held simultaneously in Paris. The followers of Maxwell and Kelvin found the interest they required in the Physical Congress; the Mathematical Congress was almost entirely engrossed in the development of the analytical ideas of Weirstrass. A lover of music nowadays must become a Wagnerian, or run the risk of hearing no music at all; so, too, the mathematician, who is not absorbed in developments of the convergency of series, must turn to the physical section for the interest he requires.

The Cambridge student of old-fashioned mathematical physics, of the school which the foreigner considered worth imitation, is now driven elsewhere, into the National Science Tripos; and so we find the serious shrinkage in the Mathematical Tripos now in rapid progress. G.

A Glossary of Botanic Terms with their Derivation and Accent. By Benjamin Daydon Jackson. Pp. xi + 327. (London: Duckworth and Co., 1900.)

MR. DAYDON JACKSON has laid those who have to consult botanical literature under a great obligation by the publication of this excellent and compendious glossary. Such a work was badly needed, and no one possesses greater qualifications for the undertaking of it than Mr. Jackson himself, who has done such good work in other departments of an analogous character.

The definitions are usually good and concise, and the errors, so far as we have been able to discover them, are surprisingly few. We cannot help, however, expressing our regret that in the definition of the words "axial" and "axile" the author did not emphasise the difference between them which has been insisted on by some of the best writers. *Axial* should be reserved for structures appertaining to the morphological axis (as distinct from its appendages), *axile* merely denoting position without reference to the morphological nature of the structure concerned. But it would be unfair to tax Mr. Jackson with a confusion only too apparent in literature in which the two terms are frequently used synonymously.

It is often of interest to know by whom a term was introduced, as it is thus possible to ascertain exactly the meaning it was originally intended to convey, and it is to be hoped that Mr. Jackson may see his way to give this information in a future edition. Some of the more recently introduced terms are already dealt with in this way in the volume before us, and we cannot but think that an extension in the direction indicated would still further improve what is already an exceedingly valuable work of reference.

Antropometria. By Dr. R. Livi. Pp. 237. (Milan: Hoepli, 1900.)

THE "Antropometria" of Dr. Livi treats of the subject under three main headings. In Part i. measurements are enumerated and described and their modifying factors reviewed. Instruction is then given in the treatment of data, with especial reference to the statistical method. Part ii. will be found to contain generalisations based on the foregoing sources of evidence, and expressed in the form of laws regulating the rate of growth in various parts of the body; some useful notes on the relation of stature and weight are appended to this part. Part iii. is devoted to an exposition of the principles and method of anthropometric identification, and a stenographic system of recording observations, similar to that used by Dr. Garson in this country, is suggested. Finally, a long table of indices will be found at the end of the volume. Like Dr. Livi's other work, the present contribution to anthropometric literature is thorough and clear; the manual will be extremely useful to students and teachers of physical anthropology.

Elementary Questions in Electricity and Magnetism. Compiled by Magnus Maclean, D.Sc., and E. W. Marchant, D.Sc. Pp. viii + 59. (London: Longmans, Green and Co.)

IT is sometimes a convenience to teachers and students to possess a collection of questions apart from those often given in text-books. There are 311 questions in this volume, arranged under 24 different headings, referring to various sections of frictional electricity, magnetism and current electricity. In addition, the book contains 14 tables of electrical constants, and answers to the numerical questions. The student who works through the exercises in the book will establish his knowledge of electrical principles upon a sound footing.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Secondary Sexual Characters.

IN his article on "Antelopes and their Recognition Marks" in the number of NATURE dated October 11, Mr. R. I. Pocock suggests that the darker colour of the males in certain species is the outcome or accompaniment of "male katabolism." As generally used, this term seems to denote some peculiarity universally associated with the male sex and giving rise to male peculiarities, so that a character which is the outcome of male katabolism does not require to be explained by the theory of sexual or that of natural selection. This is the sense in which Geddes and Thomson use the term in their "Evolution of Sex": "So brilliancy of colour, exuberance of hair and feathers, activity of scent glands, and even the development of weapons, are not and cannot be explained by sexual selection, but in origin and continued development are outcrops of a male as opposed to a female constitution." But if male katabolism is always associated with the male sex, how is it that there are so many species in which there are no secondary differences between male and female, no outcrops of male katabolism? Either male katabolism, as something different from female katabolism, does *not* exist in the males of all species, or it sometimes exists without producing any visible effect.

It is therefore evident that male katabolism in the kinetic, and not merely the potential, state occurs only in the males of those species which exhibit sexual dimorphism. After all, katabolism is only a name for certain phases of physiological activity, and we thus arrive at the hypothesis that male sexual peculiarities are the result of the peculiar katabolism of the males that possess them. Now we have a reason for such peculiar katabolism, or metabolism, in the special nervous and muscular activity which is observed in the sexual habits of those males which possess secondary sexual characters. This excitement and muscular exertion involves an increase of the metabolism, which goes far to explain, among other things, an increased production of pigment, and the consequent darker or more intense colouring of the males in many instances. The special metabolism is thus due to the habits of life, to external conditions, not to any quality necessarily associated with male sexuality.

It seems to me that, regarding the subject from the point of view I have indicated, we may arrive at the explanation of the darker colour of certain male antelopes, and also of the presence of horns in the males only. If the peculiarities of the male, in particular its colour, are thus the necessary results of physiological processes, they are sufficiently explained, without the additional suggestion that the hornless female has been compelled to adhere to the normal protective colouring of the group, while the males, by reason of their horns and superior strength, have been able to dispense with that advantage. Moreover, Mr. Pocock maintains, in other cases in which horns are developed in the male only, that the markings of the male are protective, for instance, in the kudu. J. T. CUNNINGHAM.

Penzance, October 27.

The Value of the Cylinder Function of the Second Kind for Small Arguments.

IN investigating the propagation of electrical oscillations along cylindrical conductors, the "K_0" function, which satisfies the Bessel's equation and vanishes at infinity, is used to express the vectors outside the wire. Under the conditions of the problem the approximate value of this function for very small arguments is needed. I wish to point out an error in this value, which occurs in all three important memoirs in which the subject has been discussed—viz. those of Prof. J. J. Thomson ("Recent Researches," p. 263), Sommerfeld (*Wied. Ann.*, lxvii. p. 245, 1899) and Mie (*Ann. d. Physik*, ii. p. 211, 1900), an error which can, I think, be traced to a misprint in Heine's "Kugelfunctionen."

The formula given by Heine (vol. i. p. 245) yields as the approximate value $K_0(x) = \log \frac{2}{x} - C + \frac{1}{2}\pi i$.

C is Euler's constant 0·5772 . . . but in the statement of its value which follows $-C$ is printed for C. This mistake, which is not corrected in the errata, is pointed out in the "Treatise" of Gray and Mathews (p. 88, footnote).

If we put $e^{\gamma} = \cdot 5772$, we have $K_0(x) = \log \frac{2i}{\gamma x}$. In the papers referred to, the γ appears in the numerator, which would correspond to the alteration in the sign of C. In Prof. Thomson's work the i in the numerator is omitted.

The error has no effect on the theoretical conclusions reached in the papers. The numerical results given by Sommerfeld and Mie are subject to corrections, which will not, however, affect the order of magnitude. For example, the attenuation constants worked out by Sommerfeld are something like 10 per cent. too small. W. B. MORTON.

Queen's College, Belfast, October 25.

Mosquitoes and Diseases.

AT p. 627 of your issue of October 25, while noticing Profs. Grassi and Noè's observations on *Filaria immitis*, you say "Malaria is not the only disease which is propagated by mosquitoes." May I remind your readers of Dr. Patrick Manson's important observations on *Filaria sanguinis-hominis*, originally communicated to the Linnean Society by Dr. Cobbold, on March 7, 1878 ("On the Development of *Filaria sanguinis-hominis*, and on the Mosquito considered as a Nurse": *Journ. Linn. Soc. Zool.*, xiv., pp. 304–311), and amplified later in a paper communicated on March 6, 1884 ("The Metamorphosis of *Filaria sanguinis-hominis* in the Mosquito": *Trans. Linn. Soc. Zool.*, ser. 2, vol. ii., pp. 367–388, pl. xxxix.)? W. F. KIRBY.

British Museum (Natural History), London, S.W., October 30.

OUR STELLAR SYSTEM.

IN a recently published volume[1] I endeavoured to bring together the facts relating not only to the distribution of stars generally, but to those which the spectroscope has more recently brought before us touching the distribution of the various chemical groups of stars. One of the interesting results of the inquiry was that the Milky Way, which dominates the general distribution, is also the region of the heavens in which undoubted nebulæ giving us bright-line spectra most do congregate. Nor is this all. Those so-called "stars," in the spectra of which bright lines are seen, "bright-line stars" and "new stars," which I have elsewhere shown are nebulæ or stars associated with nebulæ, are also almost entirely confined to the Milky Way. The new spectroscopic knowledge, although so priceless to the student of the chemistry of space, tells us, however, nothing as to the distances of the bodies from us; it only tells us that they lie in the galactic plane. If, however, we combine with the chemical facts the results obtained by Monck, Kapteyn and others touching the proper motions of the various kinds of stars as defined by their spectra, the results we obtain are most definite.

Dealing with the stars generally, it may be stated that the latest inquiries have suggested the following very general classification of stars depending upon temperature:—

Highest Temperature.

Gaseous stars { Proto-hydrogen stars. / Cleveite-gas stars.
Proto-metallic stars.
Metallic stars.
Stars with fluted spectra.

Lowest Temperature.

Now to make the most general statement, we find that the gaseous stars are not only confined to the Milky Way, but they are the most remote in every direction, in every galactic longitude; all of them have the smallest proper motion. The metallic stars are nearest to us, but they are *not* confined to the Milky Way. The proto-metallic stars are intermediate between these two great groups,

[1] "Inorganic Evolution," pp. 124–143.

both in regard to their proper motion and their distribution.

Now the spectroscopic similarity between the gaseous stars and the "bright-line" and "new" stars, and the planetary nebulæ, justifies our assuming provisionally that they exist under some similar conditions, and, as they are all confined to the Milky Way, we are further justified in assuming that they lie at the same distance from us.

The smaller proper motion of the hottest stars, in which I include the bright-line stars, proves that the region which gives rise to them as well as the new stars, and the planetary nebulæ, is far away *on all sides*. If it were not so we should get a very small proper motion in one direction and a very large proper motion in another.

But the stars in question in the Milky Way, which is a great circle, are all equally remote; and the only place whence such a state of things can be observed must be a point equally distant from all, that is, in the centre of the system under observation.

It is worth while to repeat that it is because we are in the centre, because the solar system is in the centre, that the observed effect arises, and if we imagine the solar system very far from the centre we should get very different proper motion conditions on this side and on that; but seeing that we have found that we get the smallest proper motion with regard to all the hottest phenomena that we know of in space, we have to consider that the still truly nebulous region is far away from us in every direction, and that it practically is limited to the plane of the Milky Way.

Photographs of some drawings made by Herschel, when he was first brought into the presence of the wonderful nebulæ with which the heavens are peopled, will give an idea of what possibly may be the condition of things touching our own system. We have amongst them drawings of "globular" nebulæ, possibly not globes, but systems looked down upon from their poles, and the possibility of that arises from the fact that many nebulæ are looked at edge-ways, and are very thin. Hence we do not know that the apparently globular clusters are not really those things looked at from the poles of their movement. We have not only those globular and elliptic nebulæ, but we have double elliptic nebulæ, which might be considered as explaining how the Milky Way happens somehow or another to be doubled. In addition to these we have well-defined ring nebulæ, the best example of which is in the constellation Lyra. It has been often imagined, up to now, by those who have considered this subject, that the Milky Way owes its appearance to the fact that there is really a spiral nebula in question, and that the stars which form the stellar system and form the companions of the sun exist at the centre of a spiral nebula. One of these spiral nebulæ, which we observe looking down on the whole system from the pole is the spiral nebula in Canes Venatici. The wonderful nebula in Andromeda, also a spiral nebula, we look at side-ways, and so it appears elliptical, and in this we notice that the greatest condensation is in the centre. But we know, from what I have stated, that our greatest condensation is not in the centre; in our case the greatest vacuity is in the centre. We are in the quiet, in the centre; so that certainly if we take our choice of these different forms, we must say that our system is much more like that of the ring nebula in Lyra than it is to such systems as those in Canes Venatici and Andromeda. We, according to Gould's work, have in the centre of our system, represented by the Milky Way, a small number of cooling stars all congregating together; outside that at an infinite distance from these relatively cool bodies, we have the Milky Way stretching with all its concomitants of gaseous stars, planetary nebulæ, bright-line stars, new stars, and so on. We must therefore consider that in our present knowledge such a condition of things as is represented by the ring nebula in Lyra fits our facts very much better than the condition which is represented by such a spiral structure as Andromeda, in which the greatest heat—I say that because there is obviously the greatest luminosity—is located at the centre. I have already referred to the proper motion evidence. It is obvious that in the case of the nebula of Andromeda, if we imagine an observer at the centre, large, medium, and small proper motions would be observed in every direction in the plane of the system, for the reason that the spirals lie in some cases near to, and in others far from, the centre, and that there are many spirals. We practically know that in our system the centre is the region of least disturbance, and therefore cooler conditions.

I now come to another point which must be considered in the next place.

Let us assume for the moment that the average brightness of stars depends upon their distance; then the

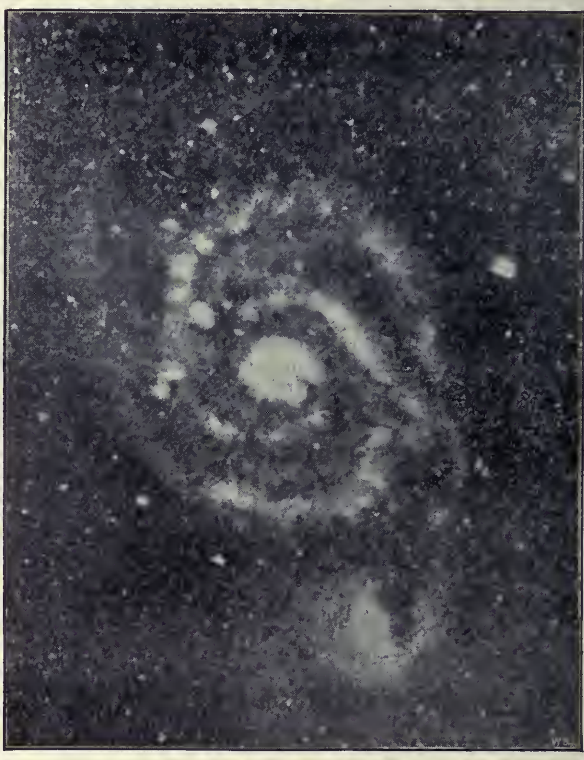


FIG. 1.—Spiral nebula of Canes Venatici, from a photograph by Dr. Roberts.

number of stars of a given magnitude indicates the stellar density at a corresponding distance. Gould from actual enumeration has given a formula which shows us that if the stars were uniformly scattered in space, and the light from them suffered no extinction in coming to us—if it did not meet anything that it could not get through—then the number of stars visible to us through a telescope, such as we have at Kensington or at Mount Hamilton, should be about 12,000,000,000. But the number actually visible, so far as counts are concerned, is certainly very much less, and, in fact, it has been estimated that the countable number, instead of being 12,000,000,000, is only about 100,000,000. This estimate seems to me very low, but I am bound to give it. When we come to consider the stars of different magnitudes in different parts of

space, we find a very great difference in relation to the plane of the Milky Way; but irrespective of this it may be said that omitting some 500 of the brighter stars, which have to be classed separately, up to the 9th magnitude, the actual and theoretical numbers are fairly accordant, but there is a distinct indication of a thinning out of stars after the 9th magnitude is passed. An example of this has been furnished by Prof. Pickering, who has given us a very useful diagram of the brightness of the stars seen within 1° from the celestial pole: that is to say, a region about 28° from the Milky Way. There is a very considerable number of stars of the 9th and 10th magnitudes, but very few of the 14th and 15th. In

Fig. 2.—The great nebula in Andromeda, from a photograph by Dr. Roberts.

that way it is possible to investigate the conditioning of stars with regard to their brilliancy in the Milky Way itself; the value of the diagram now given is that it shows what happens in a position away from the plane.

There is one other point which arises which is well worth our attention. It is a subject that we have to approach with caution, because it is such a large one, and because so little is known about it. When we look away from the plane of the Milky Way to the poles, we find, as the late Mr. Waters very conclusively proved to us by his tabulations, the greatest number of so-called nebulæ; it is very difficult to discuss this matter, because the nature of these nebulæ is undefined, we are without any information as to whether they are gaseous nebulæ or non-gaseous, and we may burn our fingers by talking about them. If, however, we consider the matter from the point of view at which we have now arrived from the complete discussion which is open to us, the question arises whether this enormous increase of nebulæ towards the poles of the Milky Way

Fig. 3.—The ring nebulæ in Lyra.

does not show us that these things are probably other universes, other systems, like our own. We must consider most of the stars which we see with our most powerful telescopes as belonging to our own system. The number, as we know, increases tremendously as the plane of the Milky Way is approached, and it is possible that as that central plane of the system contains not only stars but nebulæ, it must also contain any number of dark bodies down to the smallest meteorite, and that we may possibly have there a *vera causa* for an extinction of light near the plane of the Milky Way, which is not possible in other parts of the heavens, especially towards the galactic poles. If that be so, the increase of "nebulæ" towards the poles of the Milky Way may simply mean that we see other universes than our own in greater plenty where the conditions for seeing them become more favourable, and that is the reason why towards the poles of the Milky Way we have this overpowering number of apparently nebulous bodies. Of course if that be so, what will turn out will be that most, if not all, of them are not nebulæ at all; they are systems like our own, are clusters of stars with which our own system has absolutely no concern or connection.

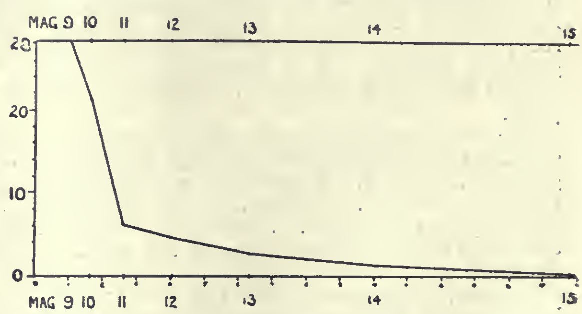


Fig. 4.—Pickering's diagram.

It follows also that the overwhelming number of very faint stars in the Milky Way are stars which would appear brighter if they happened to lie near the galactic poles.

The above suggestion is only an extension of an idea first put forward I believe by Schiaparelli. In spite of the considerable literature on the subject of the extinction

of light in space, it was not till 1889, so far as I can make out, that the possibility of such an extinction being brought about by fine particles of matter was suggested,[1] and he referred to the constitution of comets, falling stars and meteorites in support of this idea.

Now that the nebulæ and stars giving us bright-line spectra, as well as comets and falling stars, have been associated with meteorites, we must expect that the extinction of light, if produced as suggested by Schiaparelli, must very rapidly increase as the Milky Way is approached.

Hence the small magnitude stars in the Milky Way are stars of which the light has been dimmed, and the gap which separates system from system may be gathered from Pickering's diagram (Fig. 4).

We may perhaps, after the recent surveys of space, go a little further than Schiaparelli. A stoppage of light by solid bodies, whether small meteorites or condensed stars like the sun, would affect the spectrum equally from one end to the other. But we now know that many of the stars are not condensed bodies like the sun, and that in the surroundings of these, as well as in the so-called gaseous nebulæ, are gases and vapours which would undoubtedly stop the short more than the long waves of light passing through them; and there is ample evidence, as we have seen, that such stars and nebulæ are more numerous in the plane of the Milky Way than elsewhere. If we take stars of the same chemical species in and away from the Milky Way, and find differences in the lengths of their spectra in the ultra-violet, the inquiry would be carried one stage further.

It is a sure sign of the interest taken in such subjects as these, that, since the above was written, two important contributions to our knowledge have appeared. I hope it may be possible for me to refer to them on a future occasion.

NORMAN LOCKYER.

[1] "Sulla distribuzione apparente delle Stelle viribili ad occhio nudo."

THE MALARIA CAMPAIGN.

DURING the last two years, no subject has been more discussed in the medical world than paludism, and in the discussion the general public has taken an interest which purely medical matters seldom enjoy. But this is not a matter of only scientific interest, as is readily seen when one hears that five million human lives are the toll India alone pays annually to the grim spectre of malaria.

The prevention of malaria is a problem of great human, political and economic importance, and the Secretary of State for the Colonies, and many wealthy individuals in London and Liverpool, have shown their recognition of this fact by great personal interest and generous contributions of money for the founding of schools of tropical medicine in these two great seaports.

The fact of mosquito agency in the spread of malaria suspected by many, asserted by King (now almost forgotten), Laveran and Manson, and subsequently proved by the brilliant work of Ross, was not accepted at all generally two years ago. Since then, however, expeditions have been to various parts of the world to study the whole question anew.

Two expeditions have been sent to our colonies in West Africa by the Liverpool School of Tropical Medicine, another by the Royal Society to British Central Africa, some members of which subsequently followed the Liverpool men to West Africa, and lastly, in May of this year, at the instance of Dr. Patrick Manson, the London School of Tropical Medicine despatched an expedition, of which more anon, to the Roman Campagna.

In addition to these special expeditions sent out from home, Bignami, Celli, Grassi and other well-known Italian observers have been hard at work in their own country, while many medical men of our Colonial service have in their own districts been on the trail of the malaria parasites.

Germany, too, as is her wont, has been equally energetic. The great Koch, at the head of several expeditions, has visited many parts of the world and contributed largely to the sum of our present knowledge. Furthermore, Hamburg, the principal German seaport, has rightly been chosen the seat of a school of tropical medicine, whose objects are identical with those of our own schools and whose head is Prof. Nocht. It is interesting to note that the foundation of this school is due to the initiative of the Imperial Government and the enterprise of the municipal authorities of Hamburg. Save sympathy, our English schools owe nothing to the Government of an empire whose interests are more vitally affected by the problems of tropical medicine than any other in the world.

In the aggregate, the addition to our knowledge from these various sources has been immense. The whole life-history of the Hæmamœbidæ responsible for malaria has been accurately worked out, and a particular genus of mosquito (Anopheles) has been, after due trial, definitely convicted of carrying these parasites from man to man and of acting as definitive host to the parasite during its sexual phase of development. On the other hand, man, the intermediate host in this cycle of alternation of generations, has been proved equally necessary for the propagation of the species. A constant association therefore of man with mosquito seems the rule in a vicious circle, which keeps up the supply of parasites and precludes the possibility of their destruction and extinction.

One day, however, it may be shown that the human Hæmamœbidæ can complete their asexual cycle in some mammal other than man. But as yet there is no evidence of this, and Koch has stated his disbelief in the existence of any second alternative host.

As soon as there was a fair presumption (if not positive proof) that the parasites of malaria multiplied by a process of alternation of generation, in which man and a mosquito played the leading parts as intermediate and definitive hosts respectively, all workers in the subject turned their attention to the identity of the species of mosquito concerned, their habits and bionomics, and to the best method of applying practically their newly-found knowledge with a view to reducing the ravages of the fever.

New species of Anopheles were met with, and statistics of health and meteorological observations collected, with the result that our knowledge of mosquito life generally, and especially its relation to malaria, has greatly increased. Major Giles, in his recent monograph on "Mosquitoes," has collected and arranged many of the new facts, but even now we do not know how many varieties of Anopheles there are nor are we certain if all species of this genus are hospitable to the malaria parasites.

In a report recently issued by the trustees of the British Museum, Mr. F. V. Theobald gives us much further information about the Culicidæ, their distribution in nature and some points to help in the identification of species. From this report we learn that twenty-two species of Anopheles are now known, and of these ten are entirely new to science, while of Culex some ninety new species have been described.

It would appear that as a genus Anopheles is worldwide in its distribution, but is more limited in regard to species. This pamphlet is a valuable contribution to knowledge, and is evidence of the magnitude of the work now being done to increase our meagre knowledge of the Culicidæ and gives a good idea of the special difficulties of the subject.

Necessarily there has been some differences of opinion, and what has been found true in one place has been denied elsewhere. This is not remarkable if one considers how much mosquito life and habits are influenced by meteorological factors, and these obviously differ greatly in different latitudes and at different altitudes. On certain essential points, however, all observers are agreed: malaria is caused by three (possibly four) species of the Hæmamœbidæ, and these are indisputably conveyed from man to man by mosquitoes of genus Anopheles.

Another important point has been noted in West Africa by Stephens and Christophers and by Koch in Java and elsewhere. Native children of one to three years old are peculiarly the victims of malaria parasites, and as they grow older the invasion by parasites becomes less and less. These facts have been taken to prove what has long been asserted, viz., that prolonged residence in a malarial country produces a relative amount of immunity.

Koch used the presence or absence of parasites in the blood of young children as a criterion of the question as to whether malaria was endemic or merely imported. It further shows how great a danger to white men is living in close proximity to native habitations. This has been insisted on in West Africa, much to the indignation of the educated blacks.

Incidentally, additions to our knowledge of the fauna of West Africa have been made by these expeditions. Mr. Ernest Austen, of the Zoological Department, British Museum, accompanied the first expedition to Sierra Leone, and a report on his work there has been recently published by the authorities of the museum.

Fifteen hundred specimens of insects were obtained, chiefly of the Lepidoptera, Diptera and Neuroptera, though four other orders were represented in the collection. In his report Mr. Austen describes a variety of Tsetse fly (*Glossina longipalpis*), and a Muscid (probably new) known locally as the "Tumba" fly. The latter deposits its egg under the skin of man and other animals, and when the larva is hatched a boil of a peculiarly painful character is produced. The departure of Mr. Austen, immediately on his return from Sierra Leone, to South Africa with the City Imperial Volunteers has prevented us as yet of obtaining the full fruits of his work, which, now that he has safely returned, we shall eagerly look for.

The best methods of malaria prophylaxis have been much discussed. The original views of Major Ross and the first Liverpool expedition, in the light of wider and more recent knowledge, seem somewhat too sanguine. The destruction and extermination of mosquitoes by drainage and the use of culicicides, as suggested in their report, is now regarded as impracticable in some districts, although in many places these methods, in conjunction with the intelligent use of mosquito-curtains and quinine, could not fail to bring about a marked improvement.

On the whole, however, we must rely, as Dr. Manson has insisted, on the prolonged treatment of patients with quinine and during the time they have parasites in their blood on their rigorous isolation and protection from mosquitoes.

Paradoxical as it may seem, we must first aim at preserving mosquitoes from infection and so limit the chances of the dissemination of the parasites as far as possible.

It cannot be too strongly emphasised that in a malarious country where Anopheles are present a case of fever is infectious.

The value of the proper use of mosquito netting is strikingly shown by the following experiments. In March last Dr. Manson, speaking at the Colonial Institute, announced that the Colonial Office, in conjunction with the London School of Tropical Medicine, had authorised him to make an experiment to show the practicability of preventing malaria by easily applied means. A hut was to be erected in the most malarious part of the Roman Campagna with wire gauze doors and windows so as to render it mosquito proof. This hut two skilled observers were to occupy from May to October, that is, during the whole malarial season. By day they would be able to go out, but at sunset, before the mosquitoes rose, they were to enter their hut and remain closed in until daybreak. By this means it was contended they would be free from all possibility of infection by mosquitoes. In accordance with this plan Drs. Low and Sambon, of London, took up their residence in June, and the latest information is that they have passed through a trying ordeal unscathed and without any appearance of fever. This experiment is of great value, though open to criticism on the grounds that the conditions are somewhat artificial.

A similar experiment, under more natural conditions, and therefore, perhaps, of a more searching character, has been tried by the members of the second Liverpool expedition to West Africa. For four months, in the most malarious districts on the Niger, Drs. Annett, Dutton and Elliott have lived, relying, not on quinine, but only on their proper use of mosquito curtains. A recent communication shows that they have retained their health throughout their stay.

Another important experiment has recently been tried, an experiment which may be considered the complement of those just mentioned.

A consignment of Anopheles, fed on the blood of a patient in Rome known to contain parasites, was received in London from Prof. Bastianelli in July last. A son of Dr. Manson, who had not been in a malarious country since childhood, submitted himself to the bites of these infected mosquitoes. Within a fortnight Mr. Manson had a typical attack of fever, and in his blood were found parasites similar to those causing the fever of the Roman patient on whom the mosquitoes had originally been fed.

This is a crucial experiment, and proves to the hilt, if further proof were needed, that malaria is conveyed by mosquitoes from man to man. Similar "feeding" experiments had been done before, but never has such a striking and satisfactory demonstration been obtained. We have now to deal no longer with theories, but with facts, and it remains to put into practice the valuable information we have obtained as to the possibility of limiting malaria, and so improve the sanitary condition, and thereby increase the commercial prosperity of many of our greatest colonies.

R. FIELDING-OULD.

THE GEOLOGICAL SURVEY OF GREAT BRITAIN AND IRELAND.[1]

THE summary of progress of the Geological Survey of the United Kingdom for the year 1899 has been issued by Sir Archibald Geikie, Director-General. The field-work was carried out in England and Wales principally in the coal districts and bordering tracts of North Staffordshire, Leicestershire and Glamorganshire; in the slate and granite areas of Cornwall; and in the Cretaceous and Tertiary regions of the southern and southern-midland counties. In Scotland the survey of the Highland regions was prosecuted as vigorously as the nature of the ground permitted, and progress was also made in the surveys of Arran and Skye. In Ireland the revision of Silurian areas was continued.

The bulk of the summary is taken up with a somewhat detailed record of the observations made in the field; and

[1] "Summary of Progress of the Geological Survey of the United Kingdom for 1899." Pp. v + 214. (London: Printed for H.M. Stationery Office, 1900.)

this is supplemented by an account of work done in the petrographical and palæontological departments of the Survey. The field record is arranged stratigraphically, beginning with the pre-Cambrian rocks and ending with the recent deposits. Thus there are notes on nearly all the main geological systems, excepting only the Cambrian, Permian, and some of the Tertiary divisions.

In the accounts of Highland regions we find many references to the complex folds, the faults and thrust planes, which have affected the Lewisian gneiss, the schists of the "Moine series," the Torridonian and other rocks. In some cases highly altered rocks are found to overlie others which are less altered, showing that the metamorphism must have taken place before the rocks occupied their present relative positions. In places the Moine rocks contain intrusions of partially foliated hornblendic rocks, and some of these are foliated parallel to their sides and cut both the banding and the foliation of the rocks in which they occur.

It seems probable that the Moine schists of the north-west pass into and form part of the Dalradian series of the central Highlands. It is also considered probable that the Moine schists acquired their present crystalline characters since Cambrian times. Moreover, from the fact that the phyllites, quartzites, grits, conglomerates and limestones which extend from the shores of Elgin, Banff and Aberdeen to those of Islay and Jura have had a sedimentary origin, it is thought that they may yet find a definite place among pre-Cambrian or even post-Cambrian formations. In connection with this subject it is to be remembered that a belt of rocks, possibly of Arenig age, has been traced at intervals from Kincardineshire to Dumbartonshire. Here the rocks are wedged in along a line of disturbance between the Highland schists and the Old Red Sandstone; and they comprise graphitic shales, schists and cherts with Radiolaria. Rocks of this character have now been discovered in Arran.

Another interesting discovery is chronicled in the account of the work among the Silurian rocks of Ireland. The majority of the igneous rocks of the Waterford coast have been regarded as volcanic sheets intercalated contemporaneously among the Lower Silurian sediments. Evidence is now brought forward to show that these rocks, which were believed to be tuffs and agglomerates, are intrusive, the "agglomerates" having been in reality produced by a process of brecciation during a prolonged period of igneous intrusion.

It has been pointed out in a previous issue of the "Summary of Progress," that the detailed study of the rocks in the North Staffordshire Coal-field has shown that the coal-measures extend over a much wider area at or near the surface than was previously thought. Evidence furnished by a bore-hole at Thurgarton near Nottingham confirms the persistence and importance of the subdivisions that have been recognised and mapped in the North Staffordshire coalfield.

Much new information has also been gathered in the great Coal-field of South Wales, and some remarkable disturbances accompanied by over-thrusting are figured. Interesting also are the observations which have been made on the secondary rocks in this coal-basin. The occurrence of a red and green marl in the upper part of the Rhætic group at Coity, near Bridgend, and onwards to near the famous old Pyle Inn, is significant as showing the local continuation of conditions akin to those of the Keuper Marl in the Rhætic period.

Fossils of Rhætic character have been found in the passage-beds between the Red conglomerates and Lower Lias of Skye. More important still is the discovery of Rhætic fossils in the island of Arran. Here the beds which have yielded the specimens are not actually *in situ*, but are enclosed in a coarse conglomerate that fills a volcanic vent, probably of Tertiary age.

In the accounts of Lower Cretaceous rocks mention is made of fossils obtained from the Sandgate Beds, near Midhurst; and in the records of Tertiary strata there are notices of new fossiliferous localities in the Reading Beds, London Clay, Bagshot Sands, Bracklesham Beds and Barton Clay of Hampshire.

Among the Tertiary igneous rocks of Skye much new information has been obtained. The gabbro is described as consisting of numerous distinct intrusions in the form of wedges, sheets and tongues. In the basalt plateaux west of the Cuillin Hills the salient features of the slopes are due to the numerous hard intrusive sills intercalated among the softer lava flows. These latter are in general amygdaloidal. References are made to other and later sills which differ from those which follow the bedding-planes of the lavas.

Glacial drifts have received much attention in various parts of the country. Perhaps the most interesting result obtained is that having reference to the sequence in the Gower promontory of South Wales. Evidence is given to show that the deposits holding the Pleistocene fauna in the caves are newer than the raised beach, and that these bone-beds are overlain by the glacial drift.

Of special petrographical work the descriptions of the volcanic rocks of the Exeter district are noteworthy. The results of a further examination of olivine-monzonites from Argyllshire are also stated. Analysis is given of a manganese deposit of Culm-measure age at Hockworthy in Devonshire.

Of palæontological work mention should be made of the detection of phosphatic nodules with traces of probable cell-structure in the Torridonian rocks of Ross-shire. A useful catalogue is also appended of the Eocene and Oligocene type fossils which are preserved in the Museum of Practical Geology.

NOTES.

THE following Fellows of the Royal Society have been recommended by the president and council of the Society for election into the council for the year 1900, at the anniversary meeting on November 30. The names of the new members of the council are in italics. President: *Sir William Huggins, K.C.B.* Treasurer: Mr. A. B. Kempe. Secretaries: Sir Michael Foster, K.C.B., Prof. A. W. Rücker. Foreign Secretary: Dr. T. E. Thorpe, C.B. Other members of the council: *Prof. H. E. Armstrong*, *Mr. C. V. Boys*, Dr. Horace T. Brown, Mr. W. H. M. Christie, C.B., Prof. E. B. Elliott, Dr. Hans F. Gadow, *Prof. W. M. Hicks*, Lord Lister, *Prof. W. C. McIntosh*, *Dr. Ludwig Mond*, Prof. A. W. Reinold, *Prof. J. Emerson Reynolds*, *Dr. R. H. Scott*, *Prof. C. S. Sherrington*, Mr. J. J. H. Teall, *Sir J. Wolfe Barry, K.C.B.*

THE Royal Society's Medals have this year been adjudicated by the president and council as follows:—the Copley Medal to Prof. Marcellin Berthelot, For. Mem. R.S., for his brilliant services to chemical science; the Rumford Medal to Prof. Antoine Henri Becquerel, for his discoveries in radiation proceeding from uranium; a Royal Medal to Major Percy Alexander MacMahon, F.R.S., for the number and range of his contributions to mathematical science; a Royal Medal to Prof. Alfred Newton, F.R.S., for his eminent contributions to the science of ornithology and the geographical distribution of animals; the Davy Medal to Prof. Guglielmo Koerner, for his brilliant investigations on the position theory of the aromatic compounds; and the Darwin Medal to Prof. Ernst Haeckel, for his long continued and highly important work in zoology, all of which has been inspired by the spirit of Darwinism. Her Majesty the Queen has been graciously pleased to approve of the award of the Royal Medals. The medals will, as usual, be

presented at the anniversary meeting on St. Andrew's Day (November 30). The Society will dine together at the Whitehall Rooms on the evening of the same day.

To commemorate Huxley's anthropological work, the Council of the Anthropological Institute of Great Britain and Ireland has decided to found a public lecture, which will be called the "Huxley Memorial Lecture," and will be given annually at the opening of the winter session of the institute. The first Huxley lecture will be delivered by the Right Hon. Lord Avebury, F.R.S., and is announced for Tuesday, November 13, at 8.30 p.m., in the lecture theatre of the Museum of Practical Geology, Jermyn Street, S.W., which, as the scene of so much of Huxley's most impressive teaching, was felt to be the most appropriate place for such a ceremony, and has been placed for the occasion at the disposal of the Anthropological Institute. Applications for tickets of admission should be addressed to the Secretary, the Anthropological Institute, 3, Hanover Square, W., as early as possible.

Many aspects of the subject of water supply were considered by Mr. James Mansergh in his presidential address to the Institution of Civil Engineers on Tuesday. First and foremost is the question of rainfall and its accurate registration, as providing the prime factor in ascertaining the capability of supply of any given drainage area, with the flow off watersheds of varying form and geological structure, the losses by evaporation, and the discharge by floods. From the point of view of the waterworks engineer, this information is of the highest importance, and has been dealt with by previous presidents of the Institution. On the question of purity, which means, according to the now generally accepted opinion, the absence from the water—as delivered to its consumers—of any pathogenic organisms, the responsibilities of the water engineer are daily becoming more exacting. The best methods of examining and purifying waters for drinking purposes are scientific problems which have not yet been completely answered; and Mr. Mansergh showed in his address that water engineers are awaiting the expression of a definite opinion as to what organisms are actually harmful and what means should be used to remove them.

A private conference was held at the Board of Trade last week to consider the protection of the delicate instruments in use at Kew and Greenwich Observatories from magnetic disturbance, through the working of tramways and railways in the metropolis by electricity. Sir Courtenay Boyle presided, and among the officials of the Board of Trade present were Mr. F. J. S. Hopwood, Sir Thomas Blomfield and Mr. Trotter. The observatories and kindred public departments were represented by Mr. Christie (the Astronomer-Royal), Prof. Rücker, Mr. Glazebrook (Director of the National Physical Laboratory), Lieut.-Colonel Raban (Director of Works at the Admiralty), Admiral Sir W. J. Wharton (Hydrographer to the Admiralty), and Profs. Ayrton and Perry. Among those who attended as representatives of the railway and tramway interests concerned were Mr. George White (chairman) and Mr. J. Clifton Robinson (engineer) of the London United Tramways Company, Sir Benjamin Baker and Sir W. Preece. The conference is mentioned in Prof. Perry's address, on p. 46 of the present issue.

A method of diminishing the disturbing effects of electric tramways on magnetic observatories forms the subject of a note by M. Th. Moureaux in a recent number of the *Comptes rendus*. The observatory of Parc Saint Maur is at a distance of about 3·2 kilometres from a line of electric trams between Vincennes and Nogent sur Marne, and the disturbances are due chiefly to erratic currents, which exhibit their influence, not in the form of permanent displacements, but in series of vibrations, symmetrical with respect to the axis of the curves. The effect attains a maximum corresponding apparently to the starting of the cars after stoppages. M. Moureaux recommends as a remedy (1) the use of powerfully magnetised bars of rectangular or square section, (2) the addition of masses of copper with the object of increasing the moment of inertia of the oscillating system, (3) the use of a damper. The author has introduced these modifications into a declinometer and a bifilar magnet, and observations have been made with the new instruments, not only at Parc Saint Maur but also at the forts of Vincennes and Nogent, which are situated in much closer proximity to the tram-line. The general result was a decrease of the disturbing effects of the electric currents to about one-tenth of their former value. It was found that the efficiency of the instruments in recording natural disturbances was in no way impaired by the modifications in question, the records of a small disturbance made with two of the new bifilar instruments at Nogent coinciding in every detail with those taken at Parc Saint Maur.

In recognition of the services rendered to chemical science by Prof. A. W. Hofmann, new premises have been erected in Berlin for the occupation of the German Chemical Society, and the building has been named "Hofmann Haus." We learn from the *Pharmaceutical Journal* that the formal opening of the building took place on October 20, in the presence of a large number of Government officials and many representatives of the universities and other scientific institutions of Germany. The first step towards the establishment of this memorial was taken in 1888 at the celebration of Hofmann's seventieth birthday, when a sum of 300,000 marks was subscribed for the foundation of an Institute that, besides providing a laboratory for chemical investigation, would serve as a home for scientific societies and a place for meetings, lectures or exhibitions, &c. After Hofmann's death in 1892 the scheme was warmly taken up; the Empress Frederick, who had been a pupil of Hofmann's, supported it by accepting the position of patroness, and with the aid of Dr. J. F. Holtz it has now been successfully carried out, so that the Hofmann Haus could be handed over to Prof. Volhard, the president of the German Chemical Society. The same evening the first meeting was held in the new premises, when addresses were delivered by Prof. v. Baeyer of Munich, and Dr. Brunck, the Director of the Badischen Aniline and Soda Factory, describing the synthesis of indigotin and the development of its manufacture at Ludwigshafen.

At a meeting of the Council and Members of the Victoria Institute held on Monday, November 5, the president, Sir George G. Stokes, F.R.S., in the chair, Prof. Edward Hull, F.R.S., was elected secretary of the Institute in succession to the late Captain Francis Petrie.

The annual course of Christmas lectures, specially adapted to young people, at the Royal Institution, will be delivered by Sir Robert S. Ball, F.R.S., whose subject is "Great Chapters in the Book of Nature." The first lecture will take place on Thursday, December 27, at three o'clock.

A Reuter message from Simla states that since the Pasteur Institute was opened at Kasauli under the direction of Major Semple, seventy-five patients have sought admission, sixty-two of whom completed the course. In no case has the treatment ended in failure, though several of the patients had been bitten on the face by dogs and jackals. Seven British officers, twenty-five soldiers, and twelve European civilians have been treated. The rest of the patients were natives. It is evident that the institute continues to supply a pressing need.

Overhead wires conveying electric currents for tramway traction are certainly unsightly, and an accident which a *Time* correspondent reports from Vienna reminds us of their danger.

A telephone wire which had broken fell upon the overhead wire of the new electric tramway line and made connection with the earth. A lady, who got caught by the loose wire, and three men who went to her assistance, were injured by the current. Two of the persons were so seriously injured that they had to be taken to a hospital, and one is not expected to recover. From the report it is not quite clear how the woman got entangled with the telephone wire, and if the wire coiled round her in falling she might, of course, have been seriously injured, even if no current from the overhead wires of the tramway line had been passing through it. There is danger when a wire breaks, whether the wire comes in contact with one conveying a strong electric current or not. The accident might, however, have been prevented had nets been placed, as is sometimes cautiously employed, over the tramway overhead wires at places where telephone or telegraph wires cross them.

AT the Imperial Institute, on Monday, Mr. James Stirling discoursed upon "Golden Victoria, its Scenery, Geological Features, and Mines," and gave a glowing account of its resources. Victoria, although the smallest State in the Australian Continent, is the most varied with regard to its surface features, natural resources, climate, &c. It has produced, during the last half-century, more gold than any other country in the world, California excepted, viz., 256 millions out of the total 413 millions produced by Australasia. Bendigo, the deepest mine, is now 3434 feet in depth. Boring operations have proved that deep auriferous leads of about 400 miles in extent exist in various parts of the Colony. The coalfields cover, in Gippsland alone, 3000 square miles of territory, and the seams are up to 5 feet in thickness. In several valleys, such as the Latrobe, immense deposits of brown coal 276 feet thick have been found.

THE *Times* states that the practicability of utilising Mr. Marconi's system of wireless telegraphy in connection with the mail packets running between Dover and Ostend has just been tested, with satisfactory results. The vessel selected for the demonstrations was the Belgian mail packet, *Princess Clementine*, commanded by Captain Romyn. The installation was fitted up in one of the private deck cabins on the starboard side. The receiving and sending wires were connected to the foremast, the height of which had been considerably increased. The land installation was set up at La Panne, on the flat coast between Ostend and Dunkirk, the mast being about 130 ft. in height. The distance between La Panne and Dover is 61 miles. The *Princess Clementine* left Ostend soon after 11 o'clock on Saturday night and arrived at Dover at 2.40 on Sunday morning. Captain Romyn described the results so far beyond anything which the Belgian authorities had anticipated. A message was transmitted from Ostend to La Panne when the *Princess Clementine* left the Belgian port, and telegrams continued to be exchanged between the vessel and the shore at frequent intervals during the voyage to Dover. The messages were transmitted at the rate of about twenty words a minute. Messages were exchanged right up to the time the vessel reached Dover.

THE *Indian Meteorological Memoirs* (vol. xi. Part II.) contain a discussion of the observations recorded during the solar eclipse of January 22, 1898, at 154 meteorological stations in India, by Mr. J. Eliot, F.R.S. The weather was very fine over India generally, but at some of the more southerly stations the sky was overcast. The cooling effect of the eclipse was marked over the whole area; the maximum decrease of temperature ranged between 8° in the belt of totality to 4° in the extreme north and south, the maximum decrease occurring about twenty minutes later than the maximum obscuration of the sun. The movement of the air was very light generally, and was practically suspended during the greater part of the eclipse, but a noteworthy feature was the occurrence of a short, sudden gust about twenty minutes after the commencement of the eclipse at the majority of stations in and near the belt of totality. There was a remarkable increase in the amount of aqueous vapour, which commenced about the middle of the eclipse and was followed by an equally rapid decrease. This last feature was the most remarkable and unexpected phenomenon of this eclipse; it was exhibited at all stations, and was most pronounced at stations in the interior, on and near the line of totality. The diurnal variation of pressure was also considerably modified, the decrease of the amplitude averaging about ·035 inch.

AT the request of the Austrian Ministry of Agriculture, various experiments have been made by Drs. Pernter and Trabert with the view of testing the use of Mr. Stiger's apparatus for dispersing hail-clouds by gun-firing. The apparatus consists of a mortar with a long funnel fixed to the orifice; upon firing a sufficient charge of powder, rings or whirls are formed in the air and can be followed either by their hissing sound or by the particles of smoke carried up with them. The force and durability of the whirls vary with the charge, and with the size of the funnel, but it does not appear from the experiments that a greater altitude than about 400 metres was reached, which is much less than had been previously stated. It does not seem probable, therefore, that unless the hail-clouds are very low that any practical result is likely to be attained. The most that can be said in favour of the process is that while in some cases the formation of hail may have been prevented by the disturbance of equilibrium, hail frequently falls, in spite of frequent firing. The particulars of the experiments will be found in a recent number of the *Meteorologische Zeitschrift.*

DR. GOLDSCHMIDT, of Essen, has recently described a new welding process invented by himself (says *Fielden's Magazine* for October). The heat required is obtained by means of a compound called "Thermit." Metallic oxides, with aluminium, are its constituents, and it has the property of allowing a fusible mass at a high temperature to be quickly and simply produced. Its use in welding pipes and rails is its most interesting application, as, with its aid, rails can be welded immediately and economically and at any place, a melting-pot only being required. The details of the process are stated as follows:—"The melting-pot is filled with tar-oil, an inflammable mixture is added, and a match is used to ignite it. Spoonfuls of 'Thermit' are then added, which immediately ignites and produces temperatures as high as 3000° C. The highly incandescent contents of the pot consist of iron, called alumino-thermo-iron, on the top of which floats melted carborundum. An aluminium oxide is then poured on to the part of the rail to be welded, and the work is done so quickly that the melting-pot is cold and can be taken into the hand after being emptied."

SOME interesting observations on dielectric hysteresis have been lately published by M. F. Beaulard in the *Journal de Physique.* With condensers of paraffin and mica, little dissipation of energy by hysteresis was found, but with dielectrine, curves of hysteresis of the well-known forms were obtained. It was found, however, that the area of the curves and therefore the absorption of energy, varied with the period of time in which the cycle was performed, being less for slow than for rapid cycles. All this, the author considers, is explicable on M. Bouty's hypothesis, according to which the electric residue is due to a temporary retardation of the fictive polarisation on the polarising field. It is to be remarked that M. Pellat has rendered Bouty's explanation independent of the notion of fictive polarisation by proving the existence of a real polarisation varying with the time, thus explaining the phenomena observed in the present experiments, without assuming the existence of hysteresic properties in dielectrics analogous to those in magnetised bodies.

IN the *Bulletin* of the Cracow Academy, experiments are described by Constantin Zakrzewski on the electromotive force produced by the motion of a liquid through a silvered glass tube. The tube in question was a capillary tube connecting two large glass vessels half filled with water, and the electrodes terminated in the water at a short distance from the end of the tube. The flow of water was brought about by introducing compressed air into one of the vases. A current of water was always found to be accompanied by an electric current the direction of which depended on the water current, and the electromotive force was found (i) to vary as the difference of pressure at the ends of the tube; (ii) to depend on the distance of the electrodes from the ends of the tube, the effect of increasing this distance in the case of the electrode opposite the entering stream being to decrease the electromotive force. It is suggested that this result confirms the hypothesis of Quincke and Helmholtz, according to which the electromotive force has its origin in a kind of tearing of the layer of contact electricity between the silver and the water. The electromotive force depends on the thickness of the silvering, and decreases when the thickness increases. In the case of a solution of nitrate of silver, the electromotive force vanishes and changes sign when the concentration is equal to 1/3000 of the normal.

ABOUT three years ago, Dr. Folgheraiter published a description of observations of the "distinct" points and zones in the magnetisation of rocks, and showed that these singularities, of which he had observed a number in the Campagna, were due to lightning discharges. In a recent issue (No. 10) of the *Frammenti concernanti la geofisica dei Pressi di Roma*, the same author gives an account of certain measurements made with the object of determining (1) to what distance the magnetism produced by lightning produces any sensible action; (2) the direction of the magnetising lightning-discharge. The results already arrived at show that in certain singular zones (*zone distinte*) the direction of discharge is determinable, and the magnetic properties and distribution of magnetism resemble those of an ordinary magnet; while in the case of other zones it has been impossible, as yet, to ascertain either the direction of the magnetising discharge or the position of one of the two magnetic poles.

IN a recent number of *Terrestrial Magnetism and Atmospheric Electricity* (v., 2), Mr. William Sutherland puts forward a possible cause of the earth's magnetism and a theory of its variations. The cause suggested is the rotation of the electrostatic field within the earth, as Rowland's experiments have proved that a moving charge of electricity produces a magnetic field analogous to that of a current. If the earth carries round an electrostatic field in its rotation, then it will have the axis of its magnetic field identical with the axis of rotation, which is the chief approximate fact of the earth's magnetism. The actual obliquity of the magnetic to the rotational axis is traced to unsymmetrical magnetic permeability of the earth, which also causes the induction of earth currents, the secular variation of whose tracks is the cause of magnetic secular variation. The theory advanced to account for daily variation is that, under the action of the sun's rays, the oxygen and ozone of the atmosphere become the active substance of a large secondary battery or accumulator, whose alternate charge and discharge are the cause of the daily variations.

THE metamorphic rocks in Eastern Tyrone and Southern Donegal have engaged the attention of Prof. Grenville Cole, who has sought to determine the relative ages and relations of the granites and gneisses (*Trans.* Royal Irish Acad., vol. xxxi. Part ii. 1900). The oldest recognisable rocks in the two areas are schists foliated by dynamic metamorphism. In Eastern Tyrone, the occasional gneissic character of this schistose series has probably been induced by the intrusion of a granite magma, while the structures due to dynamic action have usually been lost in the new flow-structures set up. The gneisses, as well as the less altered schists, are traversed by and included in the granite of the Slieve Gallion type, which also cuts an overlying basic igneous series. In Tyrone, the older granitic material has not been exposed, but it appears in Southern Donegal, and there the granitoid gneiss is seen to be intrusive in an amphibolite series. The pure quartz-felspar-muscovite gneiss becomes rich in biotite at the junctions, and receives a foliated structure, which is due to flow and not to pressure-metamorphism. Similar relations have been observed elsewhere among the older metamorphic rocks. The Irish rocks, to which attention is now drawn, may all be of Archæan age, although the schists (termed Dalradian) are probably the oldest now remaining in the district. After referring to Dr. Callaway's researches in Galway, where he showed how gneiss has been formed by the intrusion of granite into a series rich in amphibole, the author remarks that his own observations tend to confirm the opinion that gneisses may be produced by admixture along surfaces of igneous contact, and that in such cases contact-metamorphism occurs upon a regional scale. Too often, however, the contact-phenomena on a broad scale have been removed by denudation from the surface of our granite domes, and we encounter them only in section along the flanks of the igneous mass.

THE official report of the polar expedition of the Duke of the Abruzzi is summarised in the *Times.* The following points are of interest. The *Stella Polare* left Christiania on June 12, and the farthest north point reached by it was 82° 4′. After this thet party had left the ship and established themselves on Rudolf Land. The Duke organised short excursions inland, in preparation for the great sledge expedition it was intended to undertake later. During an excursion at Christmas time the Duke and Cagni fell into a crevasse. The result of this was that two fingers of the Duke's left hand were incurably frostbitten, and the terminal joints had to be amputated. The shock of the fall and of the amputation affected the Duke's health so much that the doctor considered he was totally unfit to undertake the command of the expedition over the ice towards the Pole. Captain Cagni started on March 11, with a party consisting of ten officers and men, with numerous dogs and some sledges and kayaks. After nine days' march, during which 43½ miles were made, Cagni, finding the provisions running short, sent back Lieutenant Querini with two men. These three have not been heard of since. On March 31, when the sledge expedition had passed the 83rd parallel, Dr. Cavalli-Molinelli was sent back with two men. This, with two sledges and sixteen dogs, arrived safely at the main camp on April 24, having taken four days longer to return than to go. Cagni, in the meantime, continued his journey with three of the Italian Alpine guides. They were able to increase their speed to 9½ miles per day, and at last they reached Nansen's furthest north, 86° 14′. After a long and careful observation to make sure of this, they passed beyond, and on April 26, 1900, they touched 86° 33′ N. at about 56° E., when they decided to turn back. No land was in sight, nothing but ice in a state of thaw. Petermann's Land, which Payer believed he saw, did not exist where he stated, otherwise Cagni would have seen it early in his journey. The same is said of King Oscar Land, which would otherwise have been seen on the return march.

WE have received the November number of the *Entomologist's Monthly Magazine*, which contains notes on the occurrence in Britain of several rare Lepidoptera during the past summer.

THE *Transactions* of the Hull Scientific and Field Naturalists' Club for 1900 contain a number of papers and notes dealing with local natural history and antiquities, among which may be

mentioned one by Mr. T. Sheppard on prehistoric man in Holderness.

THE publishers have sent us the third part of Dr. Otto Fischer's elaborate treatise on the walk of man ("Der Gang des Menschen"). This section of the work, which is illustrated with seven plates, is devoted to a review of the scope of the whole investigation, and a summary of the movements of the lower limbs.

IN addition to a note by Mr. R. Hall on the change of plumage in certain birds, the August issue of the *Proceedings* of the Royal Society of Victoria (vol. xii. (n. s.), part I) contains no less than seven papers dealing with various groups of the invertebrate fauna of the colony. Two of these—on Isopod freshwater crustaceans—are by Prof. O. A. Sayce, each containing the description of a new genus. In a paper on the earthworms of the colony, Prof. Baldwin Spencer has to record two genera and a very large number of species as new to science.

IN the July issue of the *Journal* of the Straits Branch of the Royal Asiatic Society, Dr. R. Hanitsch gives an account of his recent expedition to Mount Kina Balu, British North Borneo, together with a summary of its zoological results. The examination of many of the specimens acquired was undertaken by specialists in England and Calcutta; and among the novelties are a new genus of freshwater fish and one of snakes, as well as two other new species of reptiles and one of batrachians, all these having been described by Mr. G. A. Boulenger. The paper is illustrated by two excellent photogravures of Bornean mountain scenery, as well as with two plates of the new reptiles, batrachian and fish. A second paper by Dr. Hanitsch deals with a flying frog of the genus Rhacophorus; and Mr. H. N. Ridley contributes a note on the use of the slow loris in Malay medicine.

WITH the commencement of the current volume of the *Botanical Gazette*, Prof. J. C. Arthur has vacated the editorial chair, which he has occupied since 1886. The responsible editors are now Prof. John M. Coulter and Prof. Charles R. Barnes.

WE have received a prospectus of the County School of Horticulture, Chelmsford, established by the Essex County Council, under the direction of Mr. David Houston and Mr. Charles Wakely. Instruction is given in the various branches of scientific horticulture, and certificates of proficiency are awarded. The technical instruction committee offer free instruction, travelling allowance, and, at their discretion, board and lodging, to fifteen pupils from the county of Essex, to be selected from candidates who fulfil the necessary conditions. Scholarships are also awarded, tenable for two years at the gardens of the Royal Horticultural Society, Chiswick, or other gardens approved by the committee.

NOW that the new Imperial Agricultural Department is settling down to steady work under Dr. Morris, the issue of the series of publications intended to supply colonial cultivators with the latest information on questions of interest to them is becoming more regular. The fourth number of the *West Indian Bulletin*, which has just reached us, is a double number, of 136 pages, in which Mr. Maxwell-Lefroy, the entomologist to the Department, deals with "Moth Borer in Sugar Cane"; Prof. d'Albuquerque and Mr. Bovell describe "Sugar Cane Experiments at Barbados"; Mr. Scard describes "Some Experiences with Seedling Cane in British Guiana"; the Hon. Francis Watts, "Tree Planting in Antigua" and "Care of Pastures in Antigua"; and Mr. J. H. Hart, "Some Fungi of the Cacao Tree." In addition to these contributions there are others on "Sugar Cane Experiments in Louisiana"; "The Fixation of Atmospheric Nitrogen by Leguminons Plants"; "Cacao Industry in Grenada"; "Agricultural Education in English Rural Schools," also in French rural schools; and "Fumigation of Seeds and Plants." Some of the articles are suitably illustrated. It is to be hoped that the planters and others in the various islands are making a careful study of the valuable facts thus brought to their notice by the Imperial authorities, and that they are recognising the absolute necessity of introducing more modern scientific methods into their systems of cultivation and preparation of goods for market, otherwise they must inevitably suffer in the keen competition with those who adopt all the latest discoveries of science to aid them in their calling.

WE have received from Prof. Francesco Porro, of Turin, a reprint of a note communicated by him to the *Giornale di Matematica* (Naples: B. Pellerano, February), containing a simple exposition of the problem of the motion of a planet about the sun. The paper is based on the methods adopted in Prof. Porro's university lectures.

THE September number of the *Physical Review* contains a photogravure frontispiece of the late Thomas Preston, of whom "E. M." contributes a short biography. It also contains a *résumé* of our knowledge of Becquerel rays, by Mr. Oscar M. Stewart.

MM. J. B. BAILLIÈRE ET FILS, Paris, have just published a "Catalogue général de Livres de Science" comprising the titles of books on all branches of physical and natural science. The catalogue contains more than five thousand titles, and reference to its contents is made easy by a detailed index.

MESSRS. ROBERT BOYLE AND SON, LTD., have issued a catalogue of lantern slides for lectures on ventilation, which they are prepared to lend, free of charge. The slides illustrate chiefly the Boyle system of ventilation applied to buildings of various kinds.

AN acetylene generator designed for use with optical lanterns, is included in Messrs. Newton and Co.'s supplementary list of lantern slides for the session 1900-1901. Among the new slides are sets illustrating the methods and results of eclipse observations made by Sir Norman Lockyer's expeditions of 1896 and 1898, Prof. R. W. Wood's photographs of sound waves, and Dr. J. L. Williams's photo-micrographic studies of the morphology and pathology of enamel of teeth.

A NOTEWORTHY characteristic of recent catalogues of many scientific instrument makers is the cheapness and simplicity of a large number of the instruments mentioned and illustrated. The catalogue of electrical apparatus and accessories just issued by Messrs. W. and J. George, Ltd. (late Messrs. F. E. Becker and Co.) is no exception to this commendable feature. Formerly it took years for a good piece of apparatus to find its way into an instrument maker's catalogue, but now the apparatus often becomes available a few months after it has been shown at a scientific society. We notice in the present catalogue, in addition to the usual instruments for lecture-rooms and laboratories, Davidson and Headley's localisers for Röntgen ray work, apparatus for Tesla's experiments with alternating currents of high frequency, and for Hertz wave experiments and wireless telegraphy.

MR. THOMAS MURBY has recently issued new editions of three text-books of science published by him. Prof. Meldola's book on "Inorganic Chemistry," which originally appeared twenty years ago, has been brought more or less into line with the present position of chemical science by Mr. J. Castell

Evans. The chapter on spectrum analysis might with advantage have been revised by some one familiar with recent work. The statement that "450 of the Fraunhofer lines have been observed to coincide with the lines of the iron spectrum," is, like several others, far behind the times, for more than 2000 coincidences have been photographed. A new edition (the tenth) of Skertchly's "Geology" has been prepared by Dr. James Monckman. A new section on petrology has been added to make the book suitable for the present requirements of the examiners of the Board of Education (South Kensington). A few alterations have been made, but the revision is not entirely satisfactory. For instance, a page is devoted to observations made by Mr. W. J. Henwood in 1871 on the temperatures of mines, although an excellent summary of such observations, containing far more instructive information, was given by Mr. Bennett Brough before the Society of Arts four or five years ago, and might have been used. A table of determinations of the earth's density is given, but it does not contain any of the observations made during the last ten years. Lord Kelvin remains Sir William Thomson; and only his early conclusions, and Helmholtz's, are given concerning the age of the earth. The figures, as well as many of the facts, are old-fashioned, and Dr. Monckman would have done better to have rewritten the book from the point of view of the geologist of to-day instead of attempting to adapt past ideas to present positions. Mr. Frank Rutley's little book on "Mineralogy" has deservedly had a successful career, and the twelfth edition, which Mr. Murby has just published, is a veritable *multum in parvo* as regards information of service to elementary students of mineralogy. Among the changes are the addition of a brief outline of the recently adopted treatment of crystal symmetry, a few figures of crystals, and the revision of the chemical formulæ.

THE additions to the Zoological Society's Gardens during the past week include two Patas Monkeys (*Cercopithecus patas*, ♂ ♀) from West Africa, presented by Mr. E. Jones; a Syrian Bear (*Ursus syriacus*) from Western Asia, presented by Mr. Robert de Rustafjaell; a Peregrine Falcon (*Falco peregrinus*) from Canada, presented by Mr. T. H. Small; an Osprey (*Pandian haliaetus*), captured in the Red Sea, presented by Captain T. Yendell; a Bush Dog (*Icticyon venaticus*, ♀) from Colombia, a Tayra (*Galictis barbara*) from South America, a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, three Wattled Honey-eaters (*Anthochoera carunculata*) from Australia, deposited; a Bosman's Potto (*Perodicticus potto*) from West Africa, a Bouquet's Amazon (*Chrysotis bouqueti*) from Dominica, two Ruddy Sheldrakes (*Tadorna casarca*, ♂ ♀), two Knots (*Tringa canutus*), European, purchased.

OUR ASTRONOMICAL COLUMN.

THE PLANET EROS.—A good opportunity will be offered for detecting this little object on the early evenings of November 10 and 11 before moonrise. The planet will pass near the 5th magnitude star, 4 Persei, the positions of the objects being as follows:—

	R.A. h. m. s.	Decl. ° ′
4 Persei	1 55 38 ...	+54 0
Eros, November 10 ...	1 56 53 ...	+54 21
November 11 ...	1 54 51 ...	+54 19

The position for 4 Persei is for 1900. The places of Eros are for Berlin mean midnight, corresponding to G.M.T., 11h. 7m.

On November 10 Eros will be about ½° N.E. of the star, and on November 11 about ½° N.N.W. of the star. The magnitude of the planet will be 9½. If the small stars in the region indicated are carefully watched, Eros may soon be identified by his motion.

EPHEMERIS OF COMET 1900*b*.—The following is an abridgment from a complete ephemeris communicated by Herr A. Wedemeyer to the *Astronomische Nachrichten* (Bd. 153, No. 3670).

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 8 ...	15 26 1·69 ...	+66 7 1·6
10 ...	29 5·06 ...	66 17 18·7
12 ...	32 10·10 ...	66 29 12·3
14 ...	35 16·92 ...	66 42 41·4
16 ...	38 25·58 ...	66 57 45·0
18 ...	41 36·22 ...	67 14 22·2
20 ...	44 48·90 ...	67 32 31·9
22 ...	48 3·70 ...	67 52 12·5
24 ...	51 20·75 ...	68 13 22·8
26 ...	54 40·11 ...	68 36 1·5
28 ...	15 58 1·85 ...	69 0 6·5
30 ...	16 1 26·23 ...	+69 25 35·9

NEW VARIABLE STARS.—In the *Astronomische Nachrichten* (Bd. 153, No. 3669), Herr Jos. Hisgen, of the Valkenburg Observatory, announces that he has detected variability in a star in Cygnus having the following provisional position:—

$$\left.\begin{array}{l}\text{R.A.} = 19^h\ 43^m\ 19^s.\\ \text{Decl.} = +48^\circ\ 49'{\cdot}3\end{array}\right\}(1900{\cdot}0)$$

The star reaches the 9th magnitude, and the light changes comprises at least *four* magnitudes: an approximation to the period is given as about 250 days.

IN the *Astronomische Nachrichten* (Bd. 153, No. 3670), Dr. T. D. Anderson announces the variability of a star in Pegasus, the change of which has hitherto escaped notice. The position is as follows:—

$$\left.\begin{array}{l}\text{R.A.} = 22\text{h. } 4{\cdot}6\text{m.}\\ \text{Decl.} = +13^\circ\ 38'\end{array}\right\}(1855{\cdot}0).$$

The variation in magnitude is not completely stated, but at its maximum brightness the star is about 9·9 magnitude, while at minimum it was invisible in a 3-inch telescope.

IN the same issue of the above journal, Mr. A. Stanley Williams calls attention to a new variable star in Lyra with the following co-ordinates:—

$$\left.\begin{array}{l}\text{R.A.} = 18\text{h. } 32\text{m. } 51\text{s.}\\ \text{Decl.} = +43^\circ\ 49'{\cdot}6\end{array}\right\}(1855{\cdot}0).$$

The variation of magnitude was determined photographically from plates taken with a portrait lens of 4·4 inches aperture. When at its greatest brightness the star is of about 10·5 magnitude, diminishing to a minimum of below 12 magnitude. A table of successive observations indicates maxima to have occurred about December 31, 1899, and September 3, 1900.

ASTRONOMICAL WORK AT DUNSINK OBSERVATORY.—The ninth volume of astronomical observations and researches at Dunsink, the observatory belonging to Trinity College, Dublin, consists chiefly of a catalogue giving the mean places of 321 stars, furnished by observations made with the meridian circle during 1898-9, under the direction of Prof. C. J. Joly, the Astronomer Royal of Ireland. The instrument has been provided with a new reticle having three sets of five vertical wires instead of five sets as formerly. The actual observations and preparation of the catalogue were done by Mr. C. Martin.

THE LEONID METEORIC SHOWER.

WITH the return of the Leonid epoch we are naturally led to inquire as to the prospect immediately before us. The expectation of preceding years having been grievously disappointed, observers cannot help feeling very dubious as to the return of the meteors. This is accentuated by the fact that computations made under Dr. Downing's directions show that since their return in 1866 the denser part of the stream has been subject to considerable perturbation. At the middle of November 1899 the meteors probably passed about 1¼ millions of miles inside the earth's orbit, and therefore escaped a rencontre with the earth. At the ensuing approach the conditions appear even less favourable, for the calculations indicate that the swarm will pass us by at a point about 1⅝ millions of miles nearer to

the sun than the earth. There would seem therefore to be little chance of a rich display this year.

No one can question that the calculations so far as they go are perfectly trustworthy. But is it possible, in dealing with an enormous assemblage of meteors in respect of which our knowledge is admittedly very inadequate, to define either its position, extent or density with great exactness? There is still much of mystery involved in comets and meteors. It is just possible that some development or variation in the system of Leonids will bring it prominently into view again this year. At any rate, this must be regarded as a quite possible contingency, for it is certain that every feature connected with and influencing the visibility of the meteors cannot have been allowed for. Our historical knowledge of the various attributes of the stream is very rough and incomplete, for the swarm has only made one visible return since meteoric astronomy has been recognised as an interesting and important branch of astronomy.

But, whether or not the mathematical conclusions are justified or falsified by the experiences of next week, every one of us encourages the hope that a plentiful, if not a brilliant, display of meteors will be seen. And astronomers in every part of the world will look for it as a duty. Charts will be got ready for properly recording the paths; cameras will be put into position and every preparation made to suitably record the display should it put in an appearance. The event is not only magnificent as a spectacle, but it is capable of teaching us some valuable lessons.

The moon will offer some interference this year, as she rises on November 13 at 11h. 1m., on November 14 at 12h. 8m., and on November 15 at 13h. 13m., but she will be in her last quarter, so that her light will only obliterate the faintest class of meteors. She will, unfortunately, be situated near the Sickle of Leo. The planet Mars will be placed a few degrees north-west of Regulus. On November 14, at 5h., the moon and Mars will be in conjunction, the latter being 7½ degrees north.

If the shower proves strong or feeble it should be attentively watched on the three nights of November 13, 14 and 15, if the weather is sufficiently clear for the purpose. Regular meteoric observers will also endeavour to trace some of its meteors on dates preceding and following those mentioned. It is not certain that the radiant moves like the Perseids, and we require more data with reference to the duration of the shower. Meteors certainly fall from the Sickle—and they are, presumably, true Leonids—between November 7 and 21. It will be important, therefore, to determine the exact place of the radiant on every night possible during the fortnight mentioned. This will be difficult this year on dates before the maximum owing to the strong moonlight, but it ought to be easy of attainment for a few dates after the 15th, for the moon rapidly wanes and the long nights permit of watches during the eight hours or so from the rising of the radiant at about 10h. 15m. to between 6 and 7 a.m.

The feature to which ordinary observers may usefully direct their attention, should the phenomenon recur under pretty bright aspects, is that relating to the time of maximum display and the number of meteors visible. They should be counted and recorded at, say, five-minute intervals, and registered on forms previously prepared for the purpose. Where several observers combine to effect observations they will, of course, look to different quarters of the sky and be careful to avoid numbering the same objects.

The radiant point at about the time of maximum can be well left to the care of those who have adopted the photographic method. We have already accumulated a large number of determinations by the ordinary eye method; we now require more correct values, such as it is hoped the camera will afford us.

There are many showers in the region of Leo which furnish streak-leaving meteors, and no object should be included in counts of Leonids if its direction of flight when carried backwards does not cut through the Sickle. The best of these circinal Leonid showers is at $154° + 40°$ from a point about 17 degrees north of the Leonid radiant.

While observers are watching for the Leonid display, it often happens that not only are a few bright Leonids seen, but several large meteors appear from minor radiants. It used to be the custom to term the latter "sporadic" meteors, but they belong to well-defined systems, the great majority of which have now been ascertained. In all cases where a fine meteor is seen its apparent path on the celestial sphere should be as carefully recorded as the circumstances permit, and the time of apparition noted. If this plan were followed in every case a number of multiple observations of the same meteors would be available for computing their real paths in the atmosphere. It is hoped, therefore, that this important feature of the work will not be neglected during the ensuing observations, for it need occupy little time, and will certainly provide some valuable material for after comparison and discussion. Last year, on the morning of November 15, there was a magnificent meteor many times brighter than Venus, and though it was well seen at five or six of the leading observatories in England, its path position was not particularly recorded at any one of them.

The most probable time for the recurrence of the shower will be on the night following November 14, and a watch should be commenced soon after the radiant has risen. As a rule, not many meteors are discharged from a low radiant; but what is lacking in numbers is often compensated for by appearance. The Leonids seen before midnight are usually very conspicuous, owing to their long paths, dense streaks, and apparently more gradual flights than those which appear at a later hour of the night, when the radiant has attained a fair altitude. For my own part, I certainly entertain the hope that the display will put in appearance on November 14, and that, though its splendour may fall far short of that of some previous returns, it may yet prove gratifying to those who have looked for the shower in vain during the last few years. In any case, it is to be hoped that the atmosphere will be favourable, for much depends upon the state of the sky; and it is important that we should ascertain in what strength the event returns.

W. F. DENNING.

THE NOBEL PRIZES FOR SCIENTIFIC DISCOVERY.

A BRIEF note upon the prizes endowed by the late Dr. Nobel has already been given (p. 11). A translation into English of the regulations under which the prizes will be awarded is given in *Science*, and the essential parts are here stated for the convenience of investigators unable to see a copy of the official document just distributed by the Board of Education.

The three corporations awarding the Nobel prizes are:

(1) The Royal Academy of Sciences, at Stockholm. The King is the protector of the Academy, which numbers 100 Swedish and Norwegian members and 75 foreign members. (2) The Swedish Academy, at Stockholm. The King is the protector. The members, exclusively Swedish, are limited to 18. (3) The Carolin Institute of Medicine and Surgery, at Stockholm. The number of professors is 22.

The Nobel endowment is based on the will of Dr. Alfred Bernhard Nobel, engineer, drawn up November 27, 1895. The stipulations are as follows:

"The remainder of the fortune which I shall leave shall be disposed of in the following manner: The capital, converted into safe investments by the executors of my will, shall constitute a fund the interest of which shall be distributed annually as a reward to those who, in the course of the preceding year, shall have rendered the greatest services to humanity. The sum total shall be divided into five equal portions, assigned as follows:

"(1) To the person having made the most important discovery or invention in the department of physical science.

"(2) To the person having made the most important discovery or having produced the greatest improvement in chemistry.

"(3) To the author of the most important discovery in the department of physiology or of medicine.

"(4) To the author having produced the most notable literary work in the sense of idealism.

"(5) To the person having done the most, or the best, in the work of establishing the brotherhood of nations, for the suppression or the reduction of standing armies, as well as for the formation and the propagation of peace conferences.

"The prizes will be awarded as follows: For physical science and chemistry, by the Swedish Academy of Sciences; for works in physiology or medicine, by the Carolin Institute of Stockholm; for literature, by the Academy of Stockholm; finally, for the work of peace, by a committee of five members, elected by the Norwegian Stortung. It is my expressed will that nationality shall not be considered, so that the prize may accrue to the most worthy, whether he be a Scandinavian or not."

Each of the annual prizes established by the will will be awarded at least once in the course of every period of five years, commencing with the year immediately following that in which the Nobel endowment enters on its functions, and the sum total of a prize thus awarded will in no case be less than 60 per cent. of the part of the yearly revenues disposable for the distribution of the prizes; neither can it be divided into more than three prizes at the most.

Immediately after the approval by the King of the statute of endowment, the corporations will designate the stipulated number of representatives, who will assemble at Stockholm and elect the members of the board of administration, who will have the management of the endowment fund at the beginning of the year 1901. The executors of the will will take appropriate measures to terminate the settlement of the succession. The first distribution of prizes for all sections will take place, if possible, in 1901. From the endowment resources will be deducted: First, a sum of 300,000 crowns (16,000*l.*) for each section—that is, 1,500,000 crowns (80,400*l.*) in all—which, with the interest commencing from January 1, 1900, will be used to cover, in proportion, the expenses of the organisation of the Nobel institutes in addition to the sum the board of administration shall judge necessary for the acquisition of a special site destined for the administration of the endowment and including a hall for its meetings.

The right of presenting proposals for prizes belongs to—

(1) Native and foreign members of the Royal Academy of Sciences. (2) Members of the Nobel committees for natural philosophy and chemistry. (3) Professors who have received the Nobel prize of the Academy of Science. (4) Ordinary and extraordinary professors of natural sciences and chemistry in the Universities of Upsala, Lund, Christiania, Copenhagen and Helsingfórs, in the Carolin Institute of Medicine and Surgery, the Superior Technical Royal School, as well as to the professors of the same sciences in the Stockholm High School. (5) Incumbents of corresponding chairs of at least six universities or high-schools, which the Academy of Science will select, taking care to divide them suitably between the different countries and their universities. (6) Learned men, to whom the Academy shall judge proper to send an invitation to this effect.

The invitations will be sent every year in the month of September. Proposals for the prize must be made before February 1 of the following year. They will be classified by the Nobel committee and submitted to the college of professors. The Nobel committee will decide which of the works presented shall be submitted to a special examination. The college of professors will pronounce definitely on the distribution of the prize in the course of the month of October. The vote will be taken in secret; if necessary, the question may be decided by drawing lots.

The right to present candidates for the Nobel prize belongs to the members of the Swedish Academy, the French Academy, and the Spanish Academy, which resemble the Swedish Academy in their organisation and aim; to the members of the literary departments of other academies, as well as to the members of literary institutions and societies analogous to academies; to professors of æsthetics, of literature and of history in the universities. This order must be published at least every five years.

ELECTRICAL ENGINEERING AS A TRADE AND AS A SCIENCE.[1]

I DO not intend to make this in any sense a report of the progress of our Institution during the last or any number of years. I shall not, therefore, give any account of the exceedingly good work done by Colonel Crompton and the active service corps of our Electrical Engineer Volunteers in South Africa. I shall not describe how we *fêted* our American cousins in England and France, or how they *fêted* us; nor what a wonderful success accompanied all that was attempted by us or by them or by M. Mascart and our French colleagues, although I cannot refrain from bearing my testimony to the great kindness of the Prince of Wales and the British Commission in so generously lending us the British Pavilion for our great reception, and giving us the use of one of its rooms for our office all the time of our visit to Paris.

My brother has tried to get me to introduce to your notice some novel ideas which have come to us during the last ten years in our business of lighting the city of Galway from a fairly constant water-power, using accumulators with a gas plant stand-by. It has almost come to be a practical idea to produce carbide of calcium in wet seasons and utilise it through the gas engine in dry seasons. I was also tempted to discuss the use of large gas engine plant at central stations; and another of several subjects in which I have been recently engaged has been the magnetic effect produced by systems of electric traction. But I have resisted temptation and have chosen a subject which seems to me much more important.

Your president's address is followed by no discussion. He is, therefore, privileged, but his very privileges cause him to address you with a greater sense of responsibility; he may say what he pleases, but he must be very sure that he has the best interests of the Institution at heart; the interests of the Institution as a whole, not the interests merely of a few members, and least of all ought he to think of his own interests. Nevertheless, your president speaks not as an omniscient judge, but rather as a very fallible, very prejudiced, one-sided man who, because he has devoted himself to one part of the work of this Institution, is certain to be unfair in his comments upon other parts of the work.

Your past presidents represent in this way all classes of members of this Institution. You have had scientific men, given some of them to calculation and some to experiment, and some to both; men who have advanced the study of pure science. You have had practical telegraph men, civil and military; men cunning in land and deep-sea telegraphy and telephony; men cunning in railway signalling. You have had electrical chemists. You have had manufacturers and users of all kinds of electrical appliances. You have had men who devote themselves to the teaching of electrical engineers, and who fully appreciate the fact that no good teacher ought to be out of practical touch with the profession. And nearly all of your past presidents have invented things which are now in practical use.

As each of these men has given you at least one address written from his own peculiar point of view, his prejudices are not likely to have done any harm to members who read the other addresses. I know, therefore, that you are good-naturedly prepared to give me plenty of rope. I can predict the twinkle of amusement in the faces of some of my friends when they learn that I am about to take up a subject on which we have had many debates.

In this address I mean to put before you this simple question: Is electrical engineering to remain a profession or is it to become a trade? Is this Institution to continue to be a society for the advancement of knowledge in the applications of scientific principles to electrical industries, or is it to become a mere trades union?

Of course, at the present time the outside public are willing to regard membership of this Institution as a symb[illegible] something more than the membership of a mere trades union. During the early growth of any trade, even such a trade as that of the plumber, it was really a profession. And a common trade may suddenly become a profession, if it suddenly begins to develop, as, for example, stone-masonry of a hundred years ago suddenly developed into civil engineering. Electrical engineering has been developed rapidly, so that in the past it has certainly been a profession and not a trade.

Again, we are an institution of engineers, and the general public are willing to class us with other engineering institutions —for example, the Institution of Civil Engineers. Now the title M.Inst.C.E. is a professional distinction which represents in civil engineering what F.R.C.S does in surgery, or M.R.C.P. in medicine. We owe a great deal to our association with, and recognition by, the Institution of Civil Engineers; our meetings are held in its rooms; many of our members are also its members; our proceedings are modelled on its proceedings.

Now this older Institution, governed by the best thoughts of the best British engineers, has laid it down that its associate members, that important class from which the higher class is mainly fed, shall have passed certain specified examinations in pure and applied science. I am not now suggesting that we ought to adopt this science examination method of admitting any kind of members to our Institution. I do not believe in the wholesale adoption of methods of working from another society. I am asking you early in my address to remember that this greatest of all professional engineering institutions, governed by practical men full of common sense, knowing the wants of their

[1] Inaugural Address, delivered at the Institution of Electrical Engineers on November 8, by Prof. John Perry, F.R.S., President.

profession well, insists upon a knowledge of science in its new members. If this recognition of science did not exist anywhere else in the whole world, I say that its recognition by such a thoroughly good professional society as that of the Civil Engineers ought to recommend it to all professional societies.

In Germany an enormous stride has recently been made in the raising of Engineering degrees to rank with the highest University honours. There is hardly one engineer of eminence in Switzerland, France or Germany who has not passed with honour through the classes of one of their great science Universities.[1] In Great Britain, within the last fifteen years, not only have great engineering schools been established in all the manufacturing towns, but even in Cambridge University there is one of the best schools of civil, mechanical and electrical engineering of which I know anything.

Before we think of imitating the Institution of Civil Engineers, we ought to reflect on certain fundamental distinctions between that Institution and our own, which at first sight seem to make us less professional.

There is a well-known unwritten rule of the Civil Engineers, to which there are only a few exceptions, that no contracting railway or harbour engineer can acquire the title of M.Inst.C.E. I think myself that it is a pity to draw a hard and fast line between consulting engineers and contractors. No doubt it simplifies the labour of the Council in its selection of candidates, but it gives rise to anomalies.

A man, who was once a civil engineer because he served a pupilage under his clever father, and who now is nominally at the head of his father's large practice, the real engineering work being done by many clever employees, this man may be a member. A contracting engineer who shows marvellous ability, not only in rectifying the mistakes of the designer of a large bridge or tunnel or reservoir embankment, but shows the power of Lord Kitchener in directing the work of thousands of men, so that no man need be idle, and the whole contract goes on like clockwork, and is finished well in the minimum of time, this man is ineligible. Now, in our institution, it has been recognised from the very first that manufacturers and contractors and their employees may belong to the very highest ranks of their profession. Of course, I do not mean men who simply receive the profits of businesses, or even men who merely work to obtain orders for themselves. I mean men who are not merely formally, but in reality manufacturing or contracting engineers. I mean men who, in dealing with standardised things, design new methods for quick, good, cheap production of such things. I mean men who improve old forms of things, possibly through their paid subordinates. I mean by a manufacturer fit to be a M.I.E.E., a man who might act as his own manager, and who, perhaps, has a wider outlook than on mere managerial duties. So long as a contractor or manufacturer is really an engineer, we know that we add to our strength with the addition of every such member.

But consider a contractor who only uses ordinary types of machines or electrical plant in well-known ways, surely he can hardly be said to be in the profession at all. Surely the one thing that differentiates us from mere tradesmen is that we do not follow mere rule of thumb methods; we think for ourselves, we weigh advantages and disadvantages. If every new installation required the same treatment as existing ones, the engineer would degenerate into a tradesman, and it seems to me that the electrical engineer ought to have a special fear of such degeneration.

In railway and harbour and river and sanitary engineering, in every new job, there are new difficulties to be dealt with. An engineer who designs many undertakings and sees them carried out must be a thoughtful man; he cannot help keeping himself acquainted with engineering principles, and so he is a professional man. So an architect finds that each new job requires all his experience. Every case that comes before a real physician or surgeon requires a somewhat different treatment from any old case. Every case brought before a barrister requires the exercise of all his past experience. In every case a *profession* implies the necessity for the exercise of all one's past experience; because the work one has to do is never the same as any work one has ever done before. And when I say past experience, I really mean certain general principles which one has always in one's mind, principles derived from all that one has done or seen or read about.

[1] I understand also that the great unions of manufacturers in *Germany* are about to make facilities for giving a year of real factory work to the Polytechnic students, thus perfecting the German system. In Japan we found great success in requiring students to spend their summer in real shops, their winters at college. In England it may be that we shall prefer to let apprentices have shorter factory hours than workmen, their masters being responsible for instruction being given in theory.

Electrical engineering is in a curious position. It owes its being altogether to scientific men, to the laboratory and desk-work of a long line of experimenters and philosophers. Even now the work going on in a laboratory to-day becomes the much larger work of the engineer to-morrow. When at length the laboratory experiment is utilised in engineering, we see that there is no other kind of engineering which so lends itself to mathematical treatment and exact measurement. Most of the phenomena dealt with by the electrical engineer lend themselves to exact mathematical calculation, and after calculations are made exact measurements may be made to test the accuracy of our theory. For a completed machine or any of its parts can be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by the mechanical engineer, do not destroy the body tested.

Contrast this with the calculations it is possible to make in other kinds of engineering. The pressure of earth against a revetement wall is possibly 200 or 300 per cent. greater, or 50 to 70 per cent. less than what we imagine it to be in what some limited men call theory. We use factors of safety 5 or 10 or more on all kinds of iron structure calculations, because we are aware of our ignorance of a correct method of dealing with the problems. The civil engineer never has exactly the same problem as has already been solved. In tunnelling, earthwork, building, &c., in making railways and canals, he is supremely dependent on the natural conditions provided for him; the configuration of the surface of the ground, the geological formation, the structural materials available in the neighbourhood. The story of how the engineer has to study the endlessly different ways of interaction of water and sand and gravel is told by the troublesome bars at the mouths of rivers all over the world, by the difficulties of coast and river-bank protection, by the failure of sea walls and piers. But why should I make a catalogue of the different kinds of work done by civil engineers? Every one of them needs the exercise of general scientific principles due to much experience.

Now of all such natural difficulties the consulting or contracting electrical engineer is greatly independent. Give him a source of power, and tell him what is to be done; whether he is to light a town or a building, whether with arc or incandescent lights; whether he drives a stamp mill near a mine or a pump, or a machine tool, or a spinning frame, the electrical part of the work is carried out in much the same way. Natural conditions affect him mainly in the cost of transport of his materials and the cost of labour. He can make in an easy way the most careful calculations as to the best arrangement of his conductors and machines to give maximum economy, and except for this easy calculation his work is that of a mere tradesman. He is practically independent even of the weather. There are, indeed, some of us who grumble that this easy calculation is not made easier still, who prefer to make arithmetical guesses rather than exact calculation, because perhaps we like to see a little uncertainty introduced into the problem to make it more like a problem in civil engineering. I want members to see clearly that as times go on, as our electrical engineering work gets more and more cut and dried, the man who loses the power to calculate, who loses his grip of the simple theory underlying our work, must sink more and more into the position of a mere tradesman who has no longer the right to call himself an engineer.

An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things. It has become the custom to call this *theory*, and I suppose I must follow the custom. I should prefer to call it *Science*[1] or *knowledge*. Do you remember Huxley's definition of Science? "Science," he said, "is organised common sense"; and this is really what I mean. Well, calling it *theory*, the man who is

[1] What Falstaff said of the word "occupy" we have to say of the word "Science." It is used by many people out of its proper meaning and then condemned, so that one is getting afraid to use it. In Prof. Fitzgerald's splendid inaugural address to the Dublin Section of this Institution he says: "As has recently been pointed out to me by Dr. Trouton, it would be impossible to say the same contemptuous things of *knowledge* as are said of *Science*. In Germany the word used, 'Wissenschaft,' is the one corresponding to our word 'knowledge,' and there nobody of any sense could say that 'knowledge is all humbug,' as is here often said, and still oftener thought, of 'Science.'"

permeated by theory, whose theory is so much a part of his mental machinery that it is always ready for practical application to any problem, he is the real engineer. But you must not mistake me in this matter. Eighty per cent. of the men who pass examinations in mathematics, mechanics and electricity have very little of this theory. Fifty per cent. of the writers of letters in the engineering journals in which mathematical expressions occur have almost nothing of this theory in their possession. It is unknown to foolish men. Books alone, lectures alone, experiments alone, workshop experience alone cannot teach this theory. The acumen of a Q.C. may actually prevent a man from acquiring it. A man may have much of this theory, although he may never have listened to lectures, although he may dislike the sight of a mathematical expression. I have known men who might be called illiterate to possess much theory. I have known many men who might be called good *electricians* who are almost wanting in the theory necessary for the electrical engineer.

I am speaking only of theory. Of the other qualifications for an engineer I need not here speak; they are present to the minds of all of us. A man may have any amount of knowledge; he may know how to apply his knowledge, and yet he may not be able to apply the knowledge from a want of engineering *character*.

The engineer must be a real man; he must possess individuality, the power to think for himself. He must not be like a sheep, knowing only enough to follow the bell-wether. Over and over again in the last thirty years have some of us given our students much the same sort of advice that Baden-Powell gives to scouts in that excellent little book of his. If any of you have not read that book you ought to buy it at once, and you will there find that if a man is to think for himself he must possess all kinds of knowledge, he must be constantly picking up new kinds of knowledge.

Nobody can limit the value of any kind of knowledge, but still one may say that certain things are probably more important than others. To gain what we call "theory" a good general education is most helpful—mathematical knowledge is very helpful; laboratory and workshop experience are extremely helpful. There is one qualification which the electrical engineer must have and without which all other qualifications are useless, and if a man has it no other qualification is supremely important, and this absolutely indispensable qualification is that a man shall love to think about and work with electrical things. He must like these, not because of the money he can make through electrical contrivances, nor even, I think, because of the name he may make before the world—this would be mere liking or cupboard love which has no lasting quality. So long as we have men in this country who have the true love for scientific work of which I speak, so long shall we have a real profession of electrical engineering, for such men are always scheming new contrivances and improving old ones and utilising the services of all helpful people, and especially of capitalists. When we have reached a state in which nobody schemes new things because the existing things are perfect there will no longer be a profession of electrical engineering. Of all ideas surely that of having reached *perfection* is most hateful: the idea of exact knowledge, that nothing is unknown, that there is no need for thought and therefore that to think for oneself is a sin.

And so, although we are all agreed that much standardisation in our contrivances and methods is absolutely necessary for our competition with other nations, we must follow the Americans in this matter and take care that it does not destroy invention. Of course when things are really standardised, when we have our perfect Mauser rifle or dynamo or locomotive or traction engine or electrically driven stamp mill, a Boer can buy or even manufacture them if he has money, and he can use them as well as, or possibly better than, we can. But he is not an engineer. He uses things after the engineer has done his work upon them. A stoker, a common engine-driver, the guard of a train, these are not engineers. You must have noticed that the American engineers, who surely deserve the character of being practical idealists above all other engineers, are the men who are most imbued with notions of standardisation which lead to cheapness of manufacture, and they are also the men most alive to the necessity for occasional scrapping of types of machinery when they become even a little antiquated.

Our chiefs, the men who run us all, our real men at this Institution, may be called Practical Idealists. They have imagination and judgment and individuality. They have the imagination and enthusiasm of inventors, and yet they are more than inventors, for they can estimate the worth of their own inventions and control their imaginations. They are ready to receive all new things, and yet they are not carried away. They are radicals and yet they are conservatives. They have what Mrs. Beecher Stowe called *Faculty*.

A strong imagination well under control, surely it is the greatest of mental gifts. I look round me and wonder how many of us really have it; and how many of us are only dull music-hall loving men, who scorn novels and poetry, who live utilitarian, material lives, whose aim is merely to make money through electricity, who love it not for its own self, who cherish their "tuppeny-ha'penny-worth" of theory because it is sufficient for their immediate wants. Why, even the writers of leading articles in the daily papers can talk of the wonders of electricity and what may yet come to pass; and yet we who make machines and use them and switch the marvellous thing on and off and take all sorts of liberties with it—we are like Calibans oblivious of the wonders of the fairy isle—like soulless priests making a living in the temple of Isis—like Aladdins who rub our lamp only to get the necessaries of life.

Twenty years ago some of us were laughed at for our optimism, and yet everything that we declared then to be doable has now actually been done by engineers, except the thing which was then and is now declared to be the supremely important thing, namely, the electric consumption of coal. We say now, as we said then, "The applied science of the future lies invisible and small in the operations of the men who work at pure chemistry and physics." And think of the wonderfully rapid rate at which laboratory discoveries have been made in the last eleven years, and how as the years go on they become more and more numerous; and yet many of us plod along with our work seeing no farther than our noses. A year is now more pregnant with discovery than a hundred years used to be, and yet the protective stolidity of our ancestors is upon us and we think of the latest discovery as if it were really the very last that can be made. A thousand men are measuring and trying new things in laboratories all over the world. Some of them plodding and soulless; others of them with imagination and clearness of vision. Do you think that nothing is to come from all that work?

And is it not one of the most important functions of the engineer to do as Mr. Marconi has done, to convince capitalists ignorant of science that if the successful laboratory experiment is tried on the large scale, it must also be successful? And are we going to leave all this pioneering work, with all its possibilities of great gain, albeit with possible loss, to foreign engineers, when in most cases the scientific discovery has been made in England? Are we so lacking in the hope and faith which are born of imagination and science? And must we in the future, as in the past, have to rely upon the influx of the clever foreigner like Sir William Siemens? Must we, Boer-like, always depend upon our Uitlander population, Fleming and German, Hollander, Huguenot and Hebrew, for the development of our natural resources?

Some of the best engineers I know are so exceptional that one must class them with geniuses; they have faculty and character, and so they have become engineers, even under the most unfavourable circumstances. They have passed through ordinary schools and yet developed common sense. They were pitchforked into practical work, and their liking for the work, as well as some curious kind of instinct, led them to pick up all sorts of knowledge, which have become part of their mental machinery. They continue to pick up new kinds of knowledge when these become necessary for their professional work. Unfortunately, these men do not realise how exceptional they are, and they advise boys to go direct from school into works. They forget that the other 99 per cent. of men treated in the same way as themselves can only become the hewers of wood and drawers of water to real engineers. Treated in this way, average boys are just like so many sheep: they learn just what seems absolutely necessary and no more; their acquaintance with the scientific principles underlying their trade is a hand-to-mouth knowledge, which becomes useless when their trade undergoes development.

In 1867 I was an apprentice, and when in the drawing office and pattern shop I remember well how I was chaffed for studying such a non-paying, non-practical subject as electricity. When I published my first electrical paper in 1874 before the

Royal Society, and even for some years afterwards, the real students of electricity in England could be counted on the fingers of one's hands. Many of us remember the first gramme magneto machine that came to this country, a scientific toy, in 1874. How many engineers dreamt that a great new branch of engineering had been started? Even in 1878 engineers were as a rule quite ignorant of electricity, and since then every year, although newspaper writers have talked largely of the age of electricity, the men actually engaged in electrical industries have acted as if the greatest of changes were not perpetually going on in it. To be left behind, or to become camp followers, children of Gibeon, this is the usual fate of the men who scorn theory. In 1882-4 we used to have to pay men 200*l*. and 300*l*. a year because they had a slight knowledge of electrical matters. In 1884-6 these very men were not worth twenty shillings a week; they were weeded out of the profession, and their places were taken by men of better knowledge. Two or three years after, these better men were again found to have been weeded out, because men of still better knowledge were available. And so it has gone on ever since. Men learn just enough to get posts; they settle down in these posts and scorn theory. They actually forget what little theory they once did possess. They know a great deal about existing machines, but presently they discover that improvements have been going on, and that they no longer have a right to say that they belong to the engineering profession. In every year one has told men, "You will be left behind. See A and B and C. I told them three years ago, when their names were in everybody's mouths, that they would be left behind like their predecessors, and they laughed. Now I tell you and you laugh, and you also will be left behind. Yes, I know that you get a good salary or large fees, and your head touches the sky. Nevertheless, because you neglect theory and the simple mathematics, by means of which theory is made available in practical problems, you will have to take a back seat presently, for our profession is in its early youth and is growing rapidly."

Remember that I do not now refer to the few exceptional heaven-born engineers who, in spite of bad training, do manage somehow to pick up the necessary knowledge. I speak of the average men, many of whom are now living in the same old fool's paradise. They know enough for present needs; they scorn the simple principles which underlie all our work; they scorn the easy mathematics by which these principles are most readily employed in practical problems; they will have their reward.

Just think of what is occurring at the present time. In England we have cheap coal, and it can be carried easily. In Switzerland and other countries where there is no cheap coal the water-power had to be utilised and power had to be transmitted great distances electrically. This needed high voltage, and as it is difficult to get high voltage with direct current machines, alternating currents were used, and on account of motor troubles multiphase working has been introduced. What a revelation it was to almost all of us, that visit of a year ago to Switzerland! We saw enormous schemes of lighting and traction and power. We saw electric trains driven by distant waterfalls sandwiched in among ordinary trains keeping proper time on working railways. We had known that there were great schemes carried out in Germany and America and other countries, and yet all the machines were quite unfamiliar to us. We were very much like what engineers of 1870 would have been if suddenly brought into a generating station. Is it not a fact that some of us, said to be eminent and thought to be practical, asked questions and made remarks which showed that we did not know the most elementary principles of three-phase working. Is it then any wonder that the traction schemes now being developed in England, on lines that are certainly not the best for this country of their adoption, are altogether dependent on the use of foreign electrical machinery and employ foreign electrical engineers? I am not putting this altogether fairly, for municipal procrastination has prevented our development, and yet I am not putting it altogether unfairly. We know too little theory.

I am afraid that just now we are in a rather tight place. I would give something to know how we in this room are going to get acquainted with modern electrical engineering. Our usual way of learning is by actual handling of things. But if the millions of pounds' worth of machinery coming to England every year is all foreign, and is used mainly under foreign superintendence, our usual method of study is made very difficult. True, there are American and German, and, indeed, English publications which would give a knowledge of the theory, but not, I think, to the average English electrical engineer. I know of many men, twenty-five to forty years of age, who seldom come to our meetings, and who say they are silent in discussions because they cannot be understood; perhaps these men will find a way to save us all from being left behind. There is much more that I might say in this connection. An individual Englishman may be left behind other Englishmen, and all English electrical engineers may be left behind the rest of the world, but all electrical engineers of the world may even be left behind other appliers of science. It is not merely that the incandescent mantle of the gas engineer is improving and necessitates improvements in our filaments, but, in spite of the flourishing conditions of our factories just now, I could give many other illustrations of how we shall all suffer if we do not keep adding to our knowledge. Twenty years ago, when giving some lectures in Clerkenwell to workers in the then flourishing watch trade, I ventured to prophesy the decay of that trade. But I am afraid that the case of Jonah and Nineveh is the only one in which prediction of disaster led to reform. I venture on no prophecy, therefore, because it might harden your hearts.

Much of the evil we suffer from is due to our average young men being pitchforked into works where they get no instruction, as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters could be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through common-sense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science; and he learns what he calls mathematics in such a fashion that he hates the sight of a mathematical expression all his life after.

And what is the result? English engineers do make a wonderfully intimate acquaintance with the machines and tools that they work with, but when it comes to the manufacture of new things they do it by fitting and trying, by quite unnecessary expenditure of money through trial and error. A machine is made and tried, and then another better one, until a good result is arrived at. And this method did well enough in the past, and would do well enough in the future if only we had not to compete with foreigners who can really calculate. It is not all smoke; there is a real danger in this foreign competition unless we mend our ways. There is an absolute necessity for great change in English ways; but there are so many people interested in the maintenance of old methods of working; so many people who think they will lose their bread and butter if a change takes place; so much capital, scholastic and other, invested in our old machinery, that it takes a catastrophe to produce changes. Much of the strength and weakness of England has always lain in her conservatism. We have been talking of standardisation of machinery lately, so I may say that things have been standardised in England for a long time. Now to get all the good effect of standardisation, it is occasionally necessary to go in for wholesale scrapping, and it is this scrapping part of the business that we dislike in England. We here all know that the District and Metropolitan Railways might have been worked electrically years ago just as easily as they will be when we are allowed to begin upon them, but of course the scrapping of a lot of steam locomotives was a serious thing. The loss of experience to English electrical engineers, because of this hatred of scrapping, is leading to other incalculable losses. I understand that the whole generating and line plant—the whole machinery of the Boston tramways—has been scrapped several times since they first were driven electrically. Japan has scrapped all her old civilisation just as France did. During the century now dying Germany has made the most sweeping changes in her law and school legislation, and indeed in everything. England and Spain and China, how they differ in this respect, even from England's own colonies.

Of course it may be said that English customs have grown during centuries; they are well tried, and there is no pressing need for sudden alteration. I quite agree, but unfortunately this very perfection and fitness of our customs have bred in us a want of flexibility, so that in cases where a sudden change is really necessary, we are disinclined to make the change merely because it is a change and for no other reason.

No one has ever heard me speak of the decadence of England. When the greatness and the wealth, the manliness and the strength, the healthiness and good life of England are shown

forth to the as yet ignorant world in all their magnitude there will be some astonishment. But it is our duty to keep up our high standards. We must change what is bad when we know it to be bad, and not let bad things[1] continue to exist, parasitic growths, maintained because on the whole we are strong and healthy. You will perhaps think that this is a very serious exordium when I tell you that I have introduced it all on account of the state of mathematics in our profession. I feel a sort of degradation every time that I hear a successful, clever old member of this Institution sneering at mathematics. There is a plausibility about his statements ; he himself has been very successful in life without much help from mathematics ; but indeed his sneer is doing a great deal of harm to the younger members who admire his success, who forget that he has succeeded in spite of, and not because of, his neglect of mathematics.

Our knowledge of electrical phenomena must be quantitative to be of practical use ; we must be able to calculate. Mathematics is the science of calculation, and we must therefore be able to employ, and we all do necessarily employ, less or more mathematics every hour of our professional lives. The draper and the grocer and the housekeeper merely need arithmetic. Everybody now knows some arithmetic. Everybody can add and subtract and multiply and divide, and keep accounts in some simple sort of way. This is due to the fact that arithmetic is no longer taught in the old Greek method with its twenty-seven independent characters (for our ten figures), the study of which required a lifetime, so that only old men could do multiplication, and they not only needed many hours to do one easy bit of multiplication, but declared that if the art were not practised every day it could not be remembered. Reading and writing and ciphering are now taught to everybody. It used to be that only learned men and philosophers could read, write and compute. You will remember the charge that was brought against one of Shakespeare's characters, who was said to possess mere bookish theory without practical knowledge. "And what was he?" "Forsooth a great arithmetician." Nowadays, when everybody can compute, we should say of the possessor of mere bookish theory, "Forsooth he knows the calculus."

For in mediæval times things were taught in such a way that only a few men had a chance of knowing how to read, write and cipher. We have been compelled to change all that ; the pedagogue has, by compulsion, given up his mediæval methods of teaching in these things, although in all other matters he retains them. But a time has come when we see that ciphering is not enough mathematics for us to be familiar with, we need a little algebra, we need co-ordinate geometry, we need the differential and integral calculus. The pedagogue tells us that we must follow the orthodox course of study, which takes many years ; and some of us, many of us, who have followed the orthodox method, find that we have spent so much time and mental power upon it and its thousands of unnecessary tricks and contrivances and philosophy, that we can take in no more ideas. We cannot utilise our mathematics on engineering problems because we are too old and tired and *blasé* to comprehend these problems. Nevertheless we are the only people who know mathematics, and so we publish volumes of unmeaning and useless disquisitions on problems that we do not understand. Or we know just enough mathematics to be able to show our ignorance to experts, but quite enough to impress engineers with our knowledge ; and we know just enough about engineering problems to show our ignorance to engineers, but quite enough to impress mathematicians, and what we publish is merely as the crackling of thorns under a pot.

As for the man who does understand electrical problems, he remembers that there was a something called a study of mathematics at his school, that he did pass certain examinations with much difficulty and tribulation, that the subject had no real meaning to him even when he was supposed to know it, and he now hates the sight of anything that looks like mathematics.

I tell you, gentlemen, that there is only one remedy for this sort of thing. Just as the antiquated method of studying arithmetic has been given up, so the antiquated method of studying other parts of mathematics must be given up. The practical engineer needs to use squared paper. What is the use of telling him that he has taken an unauthorised way to the study of co-ordinate geometry, that he cannot approach it except through Euclid and modern geometry and geometrical conics and algebra and trigonometry? He says the youngest child can be made to understand diagrams on squared paper.

So again the idea underlying the calculus is one that every child, every boy, every man possesses and uses every day of his life, and there are useful methods of the calculus that might be taught quite quickly to boys, and which it would be a pleasure to boys and men to use continually in all sorts of practical problems ; but of course the subject of the differential and integral calculus is one that must come at the end of a long course of what is to the average boy utterly uninteresting and unmeaning mathematics. Indeed, the average boy never reaches the subject, whose very names, differential and integral calculus, are enough to drive him frantic.

Yes, the schoolmasters say that we must follow the mediæval rules of the game, and all sorts of fine things are said about them ; but as a matter of fact we only need to bring a little common sense to bear upon schoolmasters. At present most of us stick to our arithmetic as a safe and well-tried friend. We compute after the manner of the draper and grocer and housekeeper. In finding out what is the best size of conductor, or armature winding or core, or iron and winding of a field magnet, we calculate by mere arithmetic for one size and then for another ; perhaps we have weeks of arithmetical computation before we find the right size of thing to use, and we cannot frame general rules. And some foolish person who knows a little mathematics, works at the problem (as we ought to be able to do, but are not), and he frames a general rule and we laugh at it, and sneer at mathematics because he has probably left out of account the most important consideration. We know that the result is wrong, but we cannot say why it is wrong.

Then there are some far-reaching, labour-saving ideas that we simply cannot get into our heads at all ; we cannot comprehend them. Am I sinning against the rule as to good comradeship which exists here if I say that some of us are ignorant of the most fundamental facts regulating economy in arranging sizes of conductors? Suppose we find the total cost of installing a conductor of a certain length, using one square inch section of copper. We do the same thing for other sizes, and we plot total cost and weight of mere copper on squared paper. I do not care what system we adopt if it is the same system for all sizes, and if we buy our materials from the same manufacturers and use the same kind of labour, our points will lie very nearly in a straight line on the squared paper. Hence increased cost will be proportioned to increased weight of copper, and, indeed, increased total cost will be like the mere increase in the cost of copper, taking a slightly higher price of copper per ton. Some of us, ignorant of the elementary mathematics involved in the problem, think that the mistake has been made of assuming that the cost of an installed conductor is merely the cost of the copper in it, and, of course, he must feel that it is too absurd a mistake not to be laughed over. With an elementary knowledge of mathematics his mistake would be impossible, and without such a knowledge the clever electrical engineer is constantly discovering mares' nests in the investigations which he criticises.

I know of long misleading accounts of the results of good experimental observations which might have been described in a few clear words by the aid of elementary mathematics. I know men who spend on a particular problem ten times the amount of worrying thought that would enable them to master the easy mathematics that includes all such problems. Quite recently one of our most eminent members declared to me that he had not really grasped the reason for small economy at a power station when there is a small load factor until he studied the common-sense mathematical form which has been given in a recent publication. And yet he is a man who has heard much, and read much, and talked much on this subject.

Every electrical engineer has a correct idea of how a transformer acts, or how the E.M.F. in one of the coils of an armature of a direct current or other generator, or, let us say, a rotary transformer, changes during a revolution, and how the E.M.F.'s of all the coils are combined to produce currents in the external circuits. But through how much mathematical tribulation must most of us have passed from our state of ignorance to our present state of knowledge! It is no wonder that we are disinclined to the study of a new phenomenon which seems as if it

[1] Such as our wretched system of weights and measures. Oh, young America and Australia, is it wise to waste a year of every child's life, and years of the life of every business man, merely because we do it in England? You get many of your pedagogues from us, and of course they say that without cwts., qrs., lbs., and Latin declensions and Euclid, the mind cannot be trained. Do you believe them, or are you with open eyes making a great sentimental sacrifice?

might lead us through the like tribulation. The tribulation is least because it is suffered only once if we first learn the calculus method which underlies all our work; it is greatest if we get it up in a completely new-looking form in every new problem. I speak now of what is most difficult in our study, for there is thought required in applying the calculus method. Thus, for example, in multiphase work at the present time the best mathematicians wonder how it is possible for easy calculation to be made in such a subject. What we want just now is that an electrical engineer acquainted with three-phase current phenomena should be so much a master of ordinary easy mathematics that he has a chance of discovering a very simple way of putting the matter before us. At present calculation is easy but tedious, and, indeed, repellent; but I am perfectly certain that a competent man might quickly invent methods of calculation which are not only easy but short and thinkable. Mathematicians with the requisite electrical knowledge, again, may be lacking in sympathy and humour. I know a book of more than three hundred large pages on ordinary alternating currents, and all the information in it is given far more simply in two pages of another book with which some of you are acquainted. Possibly, just now, mathematicians who are electrical and who have common sense have too much other work to do, and we must wait their leisure.

The fact is, mathematics ought to be the natural language of the electrical engineer, and at present it is a foreign language; we cannot read or write or think in it. We are at the beginning of our development, like monkeys whose necessities have increased faster than their powers of speech.

Some of you are aware that a new method of teaching mathematics has recently been introduced in nearly all evening classes in science schools throughout the country.[1] I wish I could say that there was a prospect of its being introduced in all schools, for it seems to me that this would lead to the result that all young men entering works would be masters of that kind of calculation which is most important in electrical engineering; not merely a few men having this power, but the average men, just as average men can read and write.

I am addressing engineers, men who utilise the results arrived at by scientific workers, men whose profession is applied science. But surely if we are to apply the results arrived at by scientific men, if the laboratory experiment of to-day is the engineering achievement of to-morrow, we ought to be very much alive to all that is going on in the scientific world.

All men ought to be far more alive to the importance of scientific work. On the psychological side, it is perfectly exasperating to me to see how few are the men who know that Darwin has given a key to almost all the great philosophical problems of antiquity, and that there is a great mental development accompanying the more evident engineering development now going on in the world. Again, it is the fault of our methods of education that all our great men, our most important, most brilliant, best educated men; our poets and novelists, our legislators and lawyers, our soldiers and sailors, our great manufacturers and merchants, our clergymen and schoolmasters, should remain so ignorant of physical science, the application of which by a few men not ignorant is transforming all the conditions of civilisation.[2] But, of all men, just think what it means for engineers to be ignorant of science, or neglectful of its new developments; and, of all engineers, think what it would mean if electrical engineers sinned in this way.

Except ours, all other branches of industry have taken thousands of years to grow. There were bridge and hydraulic and sanitary and harbour and river engineers in ancient Rome, and such engineers existed thousands of years before the first papyrus was written in Egypt. But no Assyrian tile or Egyptian hieroglyphic or relic from a tomb indicates that telephones or electrical motors or electric lights existed before our time. No gradual improvement in our methods of conquering nature led up from small beginnings in our electrical engineering. Our profession has not grown during thousands of years of time, like other professions. It has sprung suddenly, full grown, from the new spirit which is going to rule the souls and bodies of men, the spirit of research in pure science. The new spirit puts knowledge, mere knowledge of nature, as its highest aim. The scientific student knows that all sorts of good must come to mankind from his studies; all sorts of scientific knowledge are sure to be utilised by engineers, but in the pursuit of science the usefulness and utility of the results are of no importance. And are we—we who have received the first-fruits of the labours of scientific men, we the first-born spoilt children of the great parent of all that is to come, we who form the foremost files of the present time—are we going to turn upon our beautiful young mother and say she is useless and ugly, and she hinders our money-making, and that we are willing to kill her for the sake of the burial fee? Thank God that is the spirit of only a few of us. Have we not as an Institution gone to great expense in the publication of *Science Abstracts* in partnership with the Physical Society? That publication has been and continues to be of the very greatest value to all students of pure and applied science who read our language, for it tells them the results of all the scientific work now being done in all parts of the world. And even if some of us do not read that useful publication, do we not know that it is there to read if we like? Do we not know that it is a symbol of our redemption from the yoke of the Philistine? It is one of many signs that in answer to the question which I have asked in this address, we can truthfully say that we are professional men, that our profession has promise of enormous expansion and improvement, and that we are not mere tradesmen.

I am afraid that you will think that I have a personal interest in putting before you the claims for consideration of the pursuit of pure science, because you know that I am trying to defend Kew Observatory from imminent danger. In truth I have no interest in this matter unbecoming a president of this Institution. For two years I have been trying to reason with traction engineers. Like many other electrical engineers these gentlemen desire to use uninsulated return conductors. If they do so near a magnetic observatory certain records of terrestrial magnetic disturbances are quite spoilt. At Potsdam this sacrilege has been forbidden. At Washington, Toronto, Capetown, and most other important places, the magnetic records have already been rendered useless. Professor Rücker and I were asked by the other members of the Committee of the Royal Society which was in charge of the Kew Observatory to defend Kew, and with the help of her Majesty's Treasury we thought we were able to insist upon the use of insulated returns in all undertakings authorised by Parliament where harm was likely to be inflicted on Government observatories. I may say that the scheme designed by Mr. Clifton Robinson for using an insulated return conductor in the working of the tramways of the London United Tramways Company, in consequence of our action, was a thoroughly good scheme which it gave one satisfaction to look at, not ugly and not expensive. It seemed to me a fit scheme for any tramway system, however complex, in which overhead conductors are used. You are aware that for an electric railway or for a tramway where a conduit is employed, it is in every way better, and is in a large scheme actually cheaper, to use an insulated return. We felt therefore very happy, for magnetic observatories seemed quite safe from interference. We were, however, mistaken, for the only clause which we have been able to get inserted in all Parliamentary authorisations of undertakings leaves it to the Board of Trade to substitute other methods of protection than the insulation of the return conductors in cases where these other methods seem to be sufficiently good for the protection of laboratories and observatories, and this is why the Board of Trade appointed the Committee which met on October 31 probably for the last time.

Prof. Rücker, Prof. Ayrton, and I have made many tests on the magnetic disturbances produced by tramways and railways, particularly by the Stockton tramways and by the Waterloo and City Railway, and we have had many meetings with the traction engineers, but nothing has yet been decided.

I mention this matter, which has given great anxiety to scientific men, because I am afraid that some of you may think when you hear of it that I have been acting against the interests of the electrical industry. I beg to assure you that I have been acting in your best interests. As an electrical engineer I ought surely to regret the use of uninsulated returns, even if we leave Kew Observatory out of account. Suppose we do not now insulate our returns. Electricity will certainly return by gas and water pipes, and

[1] See summary of Lectures on Practical Mathematics; also the Science and Art Directory, and the Reports of Examiners on the Science Examinations of 1899 and 1900, all published by the Education Department, South Kensington, S.W. The reforms now advocated in mathematical and science teaching are all clearly described in a paper read before the Society of Arts in January, 1880.

[2] See articles in NATURE of July 5 and August 2

the amount of harm done to those pipes is merely a question of time. Because of the ignorance of legislators and gas and water companies, nothing is said just now; but will nothing be said at the end of ten or twenty years, when pipes are found to be eaten away everywhere? And if by a slight increase of expense, or rather, as I think, actually no increase of expense, but merely a little increase in inventiveness and common sense on the part of electrical engineers, this evil may be entirely prevented, surely it is in the interests of all of us that insulated returns should be insisted upon. But even if we do not insist on insulating the returns in all systems, surely something may be said for the giving of this protection on lines near such a magnetic observatory as Kew. Even the magnetograph records now being made have been continuous for forty-five years, and if Kew is interfered with no sum of money can compensate for the interference; for if the Observatory were removed the future observations would have no link with the past.

An engineer in this room declared that it seemed to him an injustice to hamper the progress of electric tramways "for the sake of making observations that never have given, and never may give, to the world any important results." Now, it is not so much on account of Kew that I object to this sort of observation, as to its general spirit of antagonism to scientific research.

There is no doubt that the answer to the old question, which Gilbert might have asked three hundred years ago, "What is the cause of terrestrial magnetism?" is very jealously hidden from us by Nature. The earth probably contains much iron, but its great internal heat seems to forbid our imagining the iron to be magnetic. The assumption that a negative electric charge on the rotating earth will explain things requires such an enormous charge that this assumption has been discarded. There are annual and diurnal variations of a fairly regular kind; there are storms which have some relation to the Aurora Borealis, to sunspots and to earth currents. There are small sudden changes which seem to occur almost instantaneously all over the earth. Observations of these things may be useless from some points of view, but scientific men have been, and continue to be, willing to give up time and much money for this object. Utilitarians had to be cajoled through superstition to allow observations of the stars to be carried on in ancient times, and we have no such cajolery to offer. We simply say that it has been through this sort of useless-looking method of working that all our progress in science has come.

Engineers descended from men who sneered at Cavendish and Franklin and Volta and Oersted and Ohm and Faraday, are you who utilise the results of the work so sneered at, and pile up fortunes in consequence of it, are you the men to sneer at and ridicule the scientific work of the present day because it seems to you useless?

Tell us a better method of observation; give us better suggestions as to what these magnetic phenomena may mean; but the past record of scientific observation enables us to laugh at you when you say that magnetic observations may never give the world any important results. Was Nature ever so open and yet so closed about a secret as she is about this one of terrestrial magnetism? Was there ever one whose revelation promised so much? How very little we know of electricity and magnetism! Does the mere motion of the earth, taking no account of electric charges at all, cause it to be magnetic? Almost anything is on the cards. Surely I need not appeal to your cupidity, but it is quite possible that our knowledge of this secret may enable us to tap a tremendous store of Nature's energy.

Gentlemen, this is not a trades union, and it is not a society for the furtherance of pure scientific research, but it is a society of professional men who recognise the past services of scientific observers with gratitude and respect, and hope for greater ones in the future. And shall it be said of us that our gratitude is not greater than that of Judas, to whom indeed thirty pieces of silver was doubtless a large sum; that "we have given our hearts away a sordid boon"; and that as to our future hopes we are willing to sell our birthright for a mess of pottage?

THE NEW SCIENTIFIC LABORATORIES AT KING'S COLLEGE, LONDON.

On the afternoon of October 30 the new scientific laboratories at King's College were opened by Lord Lister, in the presence of the Lord Mayor and a large and distinguished gathering of men of science. Lord Lister, after his introduction by Dr. Robertson, the principal of the college, said the occasion marked an event of great importance in the higher education of the metropolis. The necessity of practical instruction to supplement mere lectures was now fully realised; and it was in order to satisfy this want in every particular that the new laboratories had been added to King's College. In many branches the college had long been well equipped for this purpose; the Wheatstone Museum in particular would bear witness to this; but the dissecting-room, and the accommodation for the practical teaching of physiology had been very defective. But now all this had been remedied; the bacteriological laboratory and the geological department had also received many improvements; and, in short, it might safely be said that King's College was now fully abreast of the age in the opportunities it afforded for practical teaching in all departments.

The Lord Mayor proposed a vote of thanks to Lord Lister; and in seconding, the Hon. W. F. D. Smith, M.P., treasurer of the college, stated that the new buildings, together with their equipment, would, when completed, cost 20,000*l.*, and reminded his audience that only one-fifth of this sum had so far been subscribed.

Lord Lister having declared the laboratories open, they were inspected by those present.

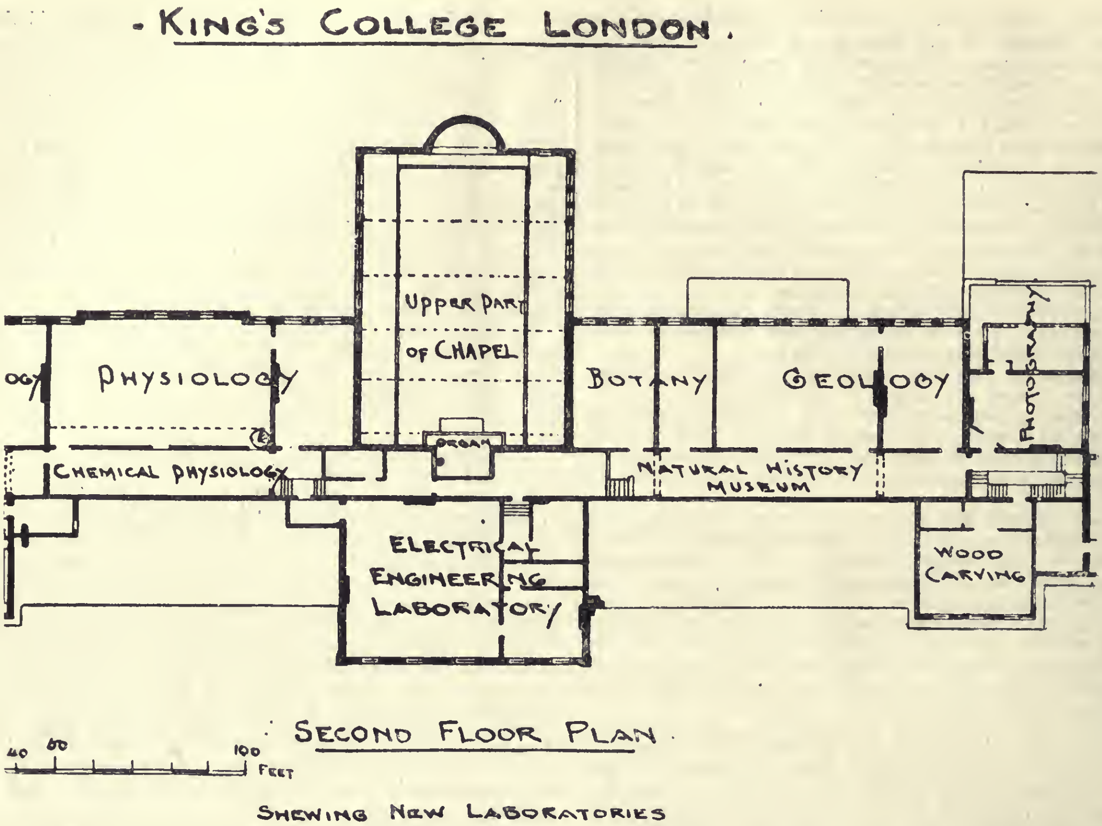
The laboratories are the result of a comprehensive scheme of extension and improvement of the teaching accommodation of the college, resolved upon by the council in the summer of 1899, and now practically completed. The biological, architectural, anatomical and mechanical departments have all benefited to a considerable extent by the new works, especially the departments first mentioned. The whole south wing of the college has been raised by an additional story, which includes the new geological, comparative anatomy and botanical departments, while the second story of the north wing, comprising the physiological and bacteriological departments, has been largely reconstructed, as has also the very fine room on the first floor now allotted to the architectural department. The reconstruction of the anatomical department and medical museum is also approximately complete, but the equipment is at present in progress.

The department of physiology comprises (1) a spacious central laboratory, seating over 100 students; the work tables are suited either for microscope work or for practical work in chemical physiology. There are in addition sixteen separate tables provided with shafting and all the necessary electrical apparatus for the study of experimental physiology, a branch of the science which is becoming every year of greater importance; (2) a large room for investigations in chemical physiology; (3) a spacious and well-fitted room for experimental physiology; (4) a dark room for photographic and galvanometer work; (5) a private workroom for the professor. These, with the necessary storerooms and accommodation for the laboratory attendants, make up a very complete suite of rooms.

In the anatomical department the dissecting room has been nearly doubled in size, and all the accessory rooms necessary in a well-equipped anatomical department are now provided. The section of the college museum which relates to pathology will also be housed in part of the old physiological rooms in the basement, and a new room has been built for the anatomical portion of the museum.

The department of bacteriology contains a practical classroom devoted to the technical education of post-graduate and other students from all parts of the world. Every student with his own hands goes through the whole practical course, and is further assisted by lectures and practical demonstrations. Several students have been especially trained with a view to investigating plague, cholera, yellow fever, madura and other tropical diseases, as well as the diseases of farm stock which are prevalent in our colonies and in foreign countries. In the technical laboratory, research work has been undertaken for the Board of Agriculture and for colonial Governments, while a number of workers have published researches on various bacteriological subjects. The new research room and library is used by advanced students and by the professor. A new feature is the bacteriological library of about 1000 volumes and pamphlets, lent by the professor for the use of the senior students. A lecture theatre has been built for the use of the bacteriological and physiological departments, and will accommodate about 200 students.

The general geological laboratory and lecture room will accommodate fifty students. The room is fitted both for lecturing



purposes and practical work, gas, water, and the electric light being laid on. In the practical class the engineering students are divided into several sections; one set of students use the petrological microscope, another set make blowpipe and chemical examinations of minerals, a third draw sections from geological maps, while a fourth set examine and draw fossils; the work of each class follows a regular schedule. The geological research laboratory is used by the professor and the more advanced students who wish to do original research. The room is fitted up similarly to the large laboratory, and contains a portion of the teaching collection and the nucleus of a library of geological works and reports.

FIG. 2.—The general laboratory and classroom in the Physiological Department.

The botanical laboratories consist of two rooms—the general laboratory for elementary work, and the research laboratory for advanced work and private research. The general laboratory provides table accommodation for twenty-four students, and is equipped with all the necessary appliances for the practical study of plants, either fresh or dry. The botanical research laboratory provides accommodation for twelve students. In this laboratory provision is made for the practical study of the chief physiological processes of plants, and for chemical investigations.

The materia medica and pharmacological collection of specimens used in teaching is contained in the upper part of the corridor, and is open to students for purposes of study; the lectures are given in another part of the building.

The Wheatstone Physical Laboratory is well equipped for delicate balance work, heat and electrical measurement, and the determination of the general physical constants. A new dark room for spectroscopic work has been specially constructed, and a room set apart for magnetic work.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The annual grant to the Botanic Garden has been raised to a sum which will make the income of the garden 670*l*., instead of 650*l*. as formerly.

The examiners for the Burdett-Coutts Scholarship in geology have not awarded the scholarship this year.

The Board of the Faculty of Natural Science have recommended that certificates should be issued entitling the following to supplicate for the degree of Doctor of Science:—Prof. Poulton, for researches on the influence of environment upon the colours of lepidopterous larvæ and pupæ; Prof. Turner, for researches on stellar photography; Prof. Miers, for researches on the red silver ores; Prof. Love, for researches on the theory of elasticity, theoretical mechanics, and the application of mathematics to physics; Prof. Weldon, for researches on natural selection; Mr. Hatchett Jackson, for researches on comparative anatomy and the morphology of lepidoptera; Mr. Lloyd Tanner, for researches on the theory of differential equations, theory of cyclotomic functions, &c.; Mr. F. A. Bather, for researches on fossil echinodermata, pelmatozoa, and blastoidea. These gentlemen will doubtless be the first to take the new research degree, which has at present only been conferred as an honorary degree.

CAMBRIDGE.—Mr. J. G. Leathem, St. John's College, has been appointed Chairman of the Examiners for the Mathematical Tripos, Part I.

Mr. R. W. H. T. Hudson, Senior Wrangler 1898, Smith's Prizeman 1900, son of Prof. Hudson of King's College, London, has been elected to a Fellowship of St. John's College.

A meeting for the purpose of establishing a memorial of the late Prof. Sidgwick is to be held in Trinity College Lodge at 3 p.m. on November 26.

The Vice-Chancellor has published a list of donations to the Benefaction Fund, bringing up the total to over 66,000*l*. Donations to the Agricultural Education Fund, for the special purpose of equipping the experimental farm, amount to nearly 1600*l*.

It is proposed to alter the regulations for Part II. of the Natural Sciences Tripos so as to permit of a candidate being placed in the first class provided he shows a sufficiently good knowledge of two subjects combined. Hitherto a first class has been awarded only for special proficiency in one subject.

DR. ERSKINE-MURRAY was appointed, at the beginning of the present session, lecturer and demonstrator of physics and mathematics at the University College, Nottingham.

THE extent of the work of the London Technical Education Board is shown in the current number of the *Technical Education Gazette*. Particulars are given of evening classes conducted under the auspices of the Board during the session 1900–1901, and though they are closely tabulated, the tables occupy 127 pages.

DR. OSCAR LOEW, for some time expert physiologist in the division of vegetable physiology and pathology of the United States Department of Agriculture, has resigned (says *Science*) in order to accept a position in the Agricultural College of the Imperial University of Tokyo, Japan, as lecturer on physiological chemistry.

SEVERAL months ago the Senate of the University of London asked the London County Council to give the name University Avenue to the road in which the university buildings are situated, now known as Imperial Institute Road. The governing body of the Imperial Institute has, however, strongly objected to the suggested alteration, and the County Council has decided to let the old name remain.

SPEAKING at St. George's Hospital on Tuesday, Sir Michael Foster referred to the inadequate provision made in our hospitals for the scientific investigation of disease. The analysis of the phenomena presented at the bed-side and in the *post mortem* room is not carried out as exactly, as completely, as fully, and as systematically as it might be. The use of the thermometer is a type of the exact analysis of clinical phenomena. In addition there is now chemical analysis, physical analysis, bacteriological analysis, but in none of our great hospitals is that analysis as complete, systematic, and exact as it should be. Such a complete analysis of all the phenomena in each case can only be carried on by means of thoroughly equipped laboratories in connection with the hospital—chemical, physical, biological, bacteriological, and other laboratories. In London the hospitals are less properly equipped in this direction not only than the hospitals of other countries, more especially America and Germany, but than even the hospitals of the provinces. It may or may not be desirable to attach to our hospitals chemical, physical and biological laboratories for the instruction of the student in introductory science; but each hospital ought to have its properly equipped clinical laboratories established for the welfare of the patient, the cost of which was as much a proper charge on the funds of the hospital as the bill for drugs or surgical appliances.

THE University College of North Wales has numbered, and still includes, among its professoriate the names of men of "light and leading" in the worlds of science, art and literature; hence its courses and laboratories, as described in the Calendar for the session 1900–1901, are worth examination. The physical, chemical, and biological laboratories occupy a large area, and the appliances provided are sufficient to enable the college to offer complete courses of work in their sciences. There is a department of electrical engineering maintained by means of an annual grant made by the Drapers' Company; and a course of lectures and experimental work, suitable for students of this branch of applied science, has just been commenced. Efforts are being made to establish a department of mining, and a conference in support of this object was held a few days ago at Rhyl. The conference was attended by representatives of the county councils, urban and rural district councils, and the technical instruction authorities of North Wales, as well as the owners and managers of mines, quarries, brick, steel and iron works in the northern half of the Principality. Students in the proposed department would, of course, attend the college lectures bearing upon their subject, but it would also be necessary to add to the staff a professor of mining and mine surveying, a professor of geology and mineralogy and an additional assistant lecturer in the chemical department, to take charge of the subject of metallurgy. It is estimated that, in order to meet the additional expense thus thrown upon the college, and for the proper maintenance of the new laboratories, an annual income of not less than 1100*l*. should be assured to the department. The establishment of mining and geological laboratories, and the provision necessary for the teaching of metallurgy would also render necessary a capital expenditure, including buildings, of about 8000*l*. All the speakers at the meeting, including Prof. Le Neve Foster, agreed in thinking that mining in North Wales would be benefited by the establishment of the department suggested, and resolutions were eventually adopted expressing support of the scheme, and pledging the conference to exert all possible means to carry it into effect.

THE work of the examinations department of the City and Guilds of London Institute is so extensive that the only satisfactory way to obtain an estimate of it is to read the annual report, which can be obtained for threepence from Messrs. Whittaker and Co., Paternoster-square, E.C. It appears, from the report just issued, that during the session 1899–1900 the total number of classes registered by the institute was 2460 as compared with 2087 in the previous session. The number of candidates' papers worked at the recent examinations was 15,557, as compared with 14,978 in the previous year, and whilst, only a few years ago, all the examinations were held on two days, they extended this year to twenty days. Mention has already been made of the desirability of closely associating the work of the technological department of the institute with that of the branch of the Board of Education dealing with technology. On August 24 an official announcement was made that an assistant secretary for technology had been appointed, and that "in the ensuing autumn it is proposesd to appoint a departmental committee, on which the County Councils and the City and Guilds of London Institute will be represented, to consider, *inter alia*, the co-ordination of the technological administration of the Board of Education with the technological work at

present carried on by educational bodies other than that board." Examinations are held in India and in several of the colonies as well as at home. The report shows that Bombay sent up this year thirty-eight candidates in cotton manufacture and dyeing, against eighteen last year. Earnest efforts are being made to provide technical instruction for operatives engaged in cotton mills in or near Bombay, and, with the further development of the cotton industry, the number of candidates from India who present themselves for the institute's examination is likely to increase. The work of the department also includes the direction of instruction and the conduct of examinations in technology and manual training. The instruction in manual training is intended exclusively for those who are preparing to become teachers in elementary or secondary schools. The difficulty of arranging for the special instruction in the methods of teaching, of which artisan students stand in need, has for some time engaged the serious attention of the institute, and, with a view of indicating the kind of lessons which it was thought desirable that County Councils might provide, a letter, enclosing a suggested scheme of instruction, was addressed in November last to the organising secretaries, and secretaries of local committees having manual training classes under their charge.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, October.—Prof. F. N. Cole gives an account of the proceedings at the seventh summer meeting of the Society, which was held in June last at Columbia University, New York City. The occasion was one of the most successful in the Society's history, having been attended by upwards of fifty members. Abstracts are given of many of the papers read. These papers will subsequently appear either in the *Bulletin* or in the *Transactions*. In connection with this gathering, the final session was devoted to an organised discussion of the following question:—What course in mathematics shall be offered to the student who desires to devote one-half, one-third or one-fourth of his undergraduate time to preparation for graduate work in mathematics? An abstract of papers read by Profs. Moore, Harkness, Osgood, Morley and Young is given by Prof. W. H. Maltbie. The discussion suggests many points of interest. Prof. (Miss) C. A. Scott furnishes an interesting article on a memoir by Riccardo de Paolis. This mathematician about twenty years since published a series of memoirs dealing with the (2, 1) transformation of the plane (cf. *Atti d. r. Accad. dei Lincei*, vol. i. (1877) pp. 511–544; vol. ii. (1878) pp. 31–50; and pp. 851–878). An exhaustive treatment is given, and Miss Scott ends thus: "the intrinsic interest of de Paolis' work is surely excuse enough for devoting some little space to it" in the *Bulletin*. References are freely made to the writings of other geometers on cognate lines. The "Notes" are full of the "Courses in Mathematics" for the winter semester at most, if not all, of the German Universities. Other details of interest to mathematicians fill up the remainder of the number, together with a long list of recent publications.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"Energy of Röntgen and Becquerel Rays and the Energy required to produce an Ion in Gases," by E. Rutherford, M.A., B.Sc., Macdonald Professor of Physics, and R. K. McClung, B.A., Demonstrator in Physics, McGill University, Montreal. Communicated by Prof. J. J. Thomson, F.R.S.

The primary object of the investigations described in the paper was the determination of the energy required to produce a gaseous ion when X rays pass through a gas, and to deduce from the result the amount of energy radiated out into the gas by uranium, thorium and the other radio-active substances.

In order to determine this "ionic energy" it has been necessary to accurately measure the heating effect of X rays and the absorption of Röntgen radiation in passing through a gas.

The method adopted to determine the ionic energy was briefly as follows:—

The maximum current between two electrodes produced by the ionisation of a known volume of the gas by the rays was determined.

In order to ionise the gas energy has to be absorbed, and the intensity of the radiation falls off more rapidly than the law of inverse squares. Assuming that the energy of the radiation absorbed in the gas is expended in the production of ions, then, knowing the coefficient of absorption of the rays in the gas, the total current produced by the complete absorption of the whole radiation given out by the bulb into the gas can be deduced.

Let i = maximum current produced by the total ionisation of the gas by the rays,
n = total number of ions produced per sec.,
ϵ = charge on an ion.
Then $i = n\epsilon$.
Let H = heating effect per sec. due to the rays when absorbed in a metal,
E = total energy of the rays in ergs,
Then E = JH, where J = Joule's equivalent.
If W = average energy required to produce an ion, then

$$nW = E = JH,$$
$$\therefore W = \frac{JH}{n} = \frac{JH\epsilon}{i}.$$

The values of H and i are experimentally determined, and, assuming the value of ϵ, namely, $6{\cdot}5 \times 10^{-10}$ electrostatic units, determined by J. J. Thomson, the value of W is found in absolute measure.

Heating Effect of the Rays.

An automatic focus tube was employed, excited by a large induction coil with a special form of Wehnelt interrupter giving 57 breaks per second. The bulb gave out intense rays of a very penetrating character.

The heating effect was measured by determining the variation of resistance in a specially constructed platinum bolometer when the rays fell upon it. The heating effect was standardised by observing the change of resistance caused by the passage of a known current through the bolometer. Special precautions were taken to screen off all heating effects except that due to the X-rays employed.

About ·55 of the incident rays were absorbed in the platinum bolometer. The energy dissipated in exciting secondary radiation at the surface of the platinum was neglected in comparison with the total energy absorbed.

The rate of supply of heat to the bolometer surface (area 92·2 square cms.) at a distance of 26 cms. from the source of the rays was about

0·00014 gramme-calorie per sec.

The total energy of the rays given out from the front surface of the platinum antikathode (omitting absorption of rays in glass of bulb, air, and screens, &c.) was

0·011 gramme-calorie per sec.

Absorption of X-Rays in Gases.

A null method was employed, as the absorption of the rays in air at atmospheric pressure was small. The rays passed through two long brass tubes with aluminium ends, and the current produced by the rays, after passing through one tube, was balanced against the current due to the other. On exhausting one tube the electrometer balance was disturbed. From measurements of the deflection per second from the balance and the deflection per second due to the rays after passing through one tube, the absorption can be calculated. The mean value of the coefficient of absorption of the rays in air at atmospheric pressure was found to be

0·000279,

or the rays would pass through 24·7 metres before absorption reduced the intensity of the radiation to one-half.

The absorption was found to be proportional to the pressure from a half atmosphere to three atmospheres.

The coefficient of absorption in carbonic acid gas was found to be 1·59 times the absorption in air.

Energy required to produce an Ion.

The current produced when a given volume of the gas was ionised by X rays was determined by means of an electrometer. In order to get rid of the secondary radiations set up when X rays strike on a conductor, the rays passed between two charged parallel plates without striking them. A guard-ring method was employed to ensure uniformity of the electric field.

The value of the ionic energy was deduced from the determination of the current, heating effect and absorption of the

rays. The mean value of the energy required to produce an ion in air at atmospheric pressure and temperature was found to be

$$1.90 \times 10^{-10} \text{ ergs}.$$

This value is much greater than the energy required to produce hydrogen and oxygen ions in the decomposition of water.

The ionic energy of air was found to be approximately the same from pressures of one-half to three atmospheres.

The method of determining the ionic energy for other gases is described, and the evidence that the "ionic energy" is the same for all gases is discussed.

Emission of Energy from Radio-active Substances.

The velocity of the ions produced by Röntgen and uranium radiation in air has been shown to be the same. The ions are thus probably the same, and it is a reasonable assumption that the same energy is required in both cases to produce them. On this assumption the energy radiated by the radio-active substances can be determined.

The radio-active material was spread over a known area and the maximum current produced between the parallel plates determined. The number of ions produced, and consequently the energy to produce them, can be calculated.

For a thick layer of uranium oxide (3·6 grammes spread over a surface of 38 cm.) the energy radiated into the gas for 1 sq. cm.) of the surface is

$$10^{-11} \text{ calories per second.}$$

This amount of energy would suffice to raise 1 c.c. of water 1° C. in 3000 years, assuming no loss of heat by radiation. From observations on the current due to a very thin layer of uranium oxide it is shown that the energy radiated into the gas is not less than 0·032 calorie per year for every gramme of the substance.

The energy radiated from thorium and radium is also considered, and the presence of the rays from radium deflected by a magnet is taken into account.

In the case of radium, which is 100,000 times more radio-active than uranium, the emission of energy per gramme of the substance is not less than 3000 calories per year.

Distance between the Charges of the Ions in a Molecule.

On the assumption that the energy absorbed in producing an ion is due to the work done in separating the ions against the forces of their electrical attraction, it can be shown that the mean distance between the charges of the ions in the molecule is

$$1.1 \times 10^{-9} \text{ cm.}$$

This is only 1/30 of the probable diameter of the atom. This result is in accordance with the view recently advanced by J. J. Thomson, that ionisation is produced by the removal of a negative ion from the molecule, and that the negative ion is only a small fraction of the mass of an atom.

Minimum Potential required to produce a Spark.

If the production of ions is necessary before a spark can pass, it can readily be deduced from the value of ionic energy that a spark cannot pass for a potential difference less than 175 volts. Experiments have shown that the minimum value is over 300 volts The theoretical value is of the same order, but from the complexity of the phenomena a very close agreement could not be expected.

Efficiency of a Fluorescent Screen.

Photometric comparisons were made of the light from a fluorescent screen, excited by the X-rays, with the standard Hefner-Alteneck amyl lamp. The energy of the visible radiation from the amyl lamp has been determined in absolute measure by Tumlirz (*Wied. Annal.*, vol. 38, p. 640), and the energy of the rays was measured by the method explained earlier in the paper. From these results the efficiency of the transformation of X-rays into visible light (compared with the amyl lamp) was found to be

4·4 per cent.

A method of determining the intensity of X-rays in absolute measure by photometric observations is explained.

Entomological Society, October 17.—Mr. G. H. Verrall, President, in the chair.—Mr. A. H. Jones exhibited a series of *Pararge maera*, a light form resembling *P. megoera* from the Basses Alpes and the Cévennes; a dark form approaching *P. hiera* from Cortina; and an intermediate form from the Italian Lakes; also a variety of *Lycaena corydon*, female, in which the under wing showed a decided blue coloration, taken at Lago di Loppio near Riva. Dr. Chapman suggested that the union between the three named species of *Pararge* was very near, if the species were not indeed identical.—Mr. A. J. Scollick exhibited a specimen of *Cethosia cyane*, a species inhabiting North-West India, which had been taken this year on the wing near Norwich. It was suggested by Mr. Distant that this was a case of accidental importation, probably in the pupal condition.—Mr. H. Rowland-Brown exhibited specimens of *Erebia glacialis*, taken this year on the Stelvio pass, showing transitional forms to the var. *Alecto*. He said that the typical form and the variety were not found flying together, but on opposite sides of the valley. Dr. Chapman observed that the darker specimens approached to the form of *E. melas* found in the neighbourhood of Cortina-di-Ampezzo. Specimens of *E. glacialis* also exhibited from Saas Fée and Evolena showed marked inferiority in size and brilliancy of colour.—Mr. W. L. Distant exhibited a piece of Hawkesbury sandstone from Australia, showing the borings of Termites, and in connection with the same communicated a note from the *Proceedings* of the Linnean Society of New South Wales (Pt. iii. 1899, p. 418), as follows:—"Mr. D. G. Stead exhibited specimens of Hawkesbury sandstone (1) From the sea-shore between tide marks showing the tunnelling of Marine Isopods (*Sphaeroma*) with the living animals *in situ*; and (2) from the hill-tops overlooking Port Jackson, offering examples of the borings which so often attract notice and the production of which has been attributed to Hymenoptera, and also to the Termites. Since last meeting Mr. Stead reported that he had investigated the matter and that, after breaking up a quantity of stone, he had come upon Termites, of a species at present undetermined, actually at work, specimens of which he exhibited.—Mr. M. Burr exhibited a male and female specimen of *Anisolabis colossea*, Dohrn., from New South Wales—the largest known earwig in the world.

PARIS.

Academy of Sciences, October 29.—M. Maurice Lévy in the chair.—On a method of Riemann and on linear partial differential equations, by M. R. Liouville.—The application of the interference method to the measurement of wave-lengths in the solar spectrum, by MM. A. Perot and Ch. Fabry. The method described permits of the direct comparison of the wave-length of a given dark line in the solar spectrum with a known cadmium ray, a single experiment requiring only the measurement of the diameters of two rings.—On the ammoniacal arsenates of nickel, by M. O. Ducru. Nickel forms three ammoniacal arsenates corresponding to those previously described for cobalt.—On the selenides of cobalt, by M. Fonzes-Diacon. Cobalt combines with selenium giving according to the conditions of the experiment $CoSe_2$, Co_2Se_3, Co_3Se_4, and CoSe. At a high temperature all these selenides are reduced by hydrogen to Co_2Se, which, after prolonged contact with the gas, loses all its selenium.—Modification of the chemical properties of some simple bodies by the addition of very small proportions of foreign substances, by M. Gustave LeBon. Magnesium and aluminium amalgams behave differently, from either of their constituents taken singly, towards water and air.—Cellulose, precipitated cellulose and hydrocellulose, by M. Leo Vignon. The reducing properties, velocity of saccharification, and heats of combustion of cellulose that had been submitted to different modes of treatment were determined. Solutions of strong alkali produced apparently a polymerisation, and similar effects were caused by dilute acids, but none of these celluloses possessed any reducing properties, and thus were sharply differentiated from the oxycelluloses.—On two ketones containing the acetylene grouping, acetyl-œnanthylidene and benzoyl-œnanthylidene. Transformation into β-diketones by hydration, by MM. Ch. Moureu and R. Delange. Amylacetylene $CH_3.(CH_2)_4—C\equiv CH$ is converted into its sodium derivative, and this, suspended in ether and treated with the acid chloride, gives the corresponding ketone. With strong sulphuric acid these ketones are hydrolysed, giving the β-diketones $C_5H_{11}.CO.CH_2.CO.CH_3$ and $C_5H_{11}.CO.CH_2.CO.C_6H_5$.—Transformation of α-amido-acids into phenylhydantoïns, by M. A. Mouneyrat. A description of the preparation and

properties of γ-phenylhydantoin, phenyl-methyl-hydantoin, phenyl-ethyl-hydantoin, phenyl-isobutyl-hydantoin, and phenyl-benzyl-hydantoin.—On the regeneration of a confined volume of air by means of sodium peroxide, by M. George F. Joubert.—On the gaseous exchanges between plants and the atmosphere, by M. Th. Schlœsing, junr. An extension of previous work on the same subject to plants growing in soils containing ammonia salts as the only available source of nitrogen, and free from the nitrifying organism.—A case of rapid transformation of wood into a substance resembling a combustible fossil, by M. G. Arth.—On the examination of contaminated waters for cystine, by M. M. Molinié. The author has repeated the experiments of M. Causse on this subject, and finds that the reagent proposed as a test for cystine gives a permanent orange coloration, not removable by sulphurous acid, even in distilled water. Further examination of the reaction showed that the tint is produced only when the test solution has an acid reaction. The test would thus appear not to be a characteristic one for cystine.—On a new sporozoa from the larvæ of Diptera, by M. Louis Léger.—Precocity and sexual periodicity in man, by M. Gustave Loisel. An attempt to explain the phenomenon of sexual periodicity by the periods in the evolution of spermatogenesis in man and the higher vertebrates.

NEW SOUTH WALES.

Royal Society, August 8.—The President, Prof. Liversidge, F.R S., in the chair.—The President announced that the third science lecture of the Royal Society of New South Wales' series for 1900, viz. a Study of the Mechanics of the Human Frame-work, by Prof. T. P. Anderson Stuart, would be given in the Royal Society's House on August 22.—The following papers were read: Notes on rack railways, by C. O. Burge.—On the damage done to the Seal Rocks lighthouse by lightning on July 10, by C. W. Darley. The author said that the lighthouse tower was fitted with a solid copper lightning conductor extending half round, and was attached at the top to the copper roof of the lantern. The electricity evidently entered the vane on top of the lantern dome, the end being bent and fused, and thence passed down the lightning rod. A portion of the current was communicated to the electric bell wires on the middle floor. These wires led to the principal and assistant light-keepers' quarters, and were laid underground in a 1-inch iron pipe for a distance of 300 feet. The current had tried to make earth at three places, for the pipe was burst and the earth above blown away.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 8.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—On the Transmission of Force through a Solid: Lord Kelvin, G.C.V.O.—In a Simple Group of an Odd Composite Order every System of Conjugate Operators or Sub-groups includes more than Fifty: Dr. G. A. Miller.—Prime Functions on a Riemann Surface: Prof. A. C. Dixon. (i) Further Note on Isoscelians; (ii) On Two In-triangles which are similar to the Pedal Triangle: R. Tucker.—(i) A General Congruence Theorem relating to the Bernoullian Function; (ii) On the Residues of Bernoullian Functions for a Prime Modulus, including as Special Cases the Residues of the Eulerian Numbers and the I-numbers: Dr. Glaisher, F.R.S.—On Green's Function for a Circular Disc: H. S. Carslaw.—On the Real Points of Inflexion of a Curve: A. B. Basset, F.R.S.—On Quantitative Substitutional Analysis: A. Young.—On a Class of Plane Curves: J. H. Grace.—On Group Characteristics, and on some Properties of Groups of Odd Order: Prof. Burnside, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address: Prof. J. Perry, F.R.S.

FRIDAY, NOVEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Observations of Nebulæ made at the Chamberlin Observatory, University Park, Colorado: Prof. H. A. Howe.—On the Appearance of Saturn's Crape Ring in 1900: E. M. Antoniadi.—Observations of Jupiter and his Satellites made at Mr. Crossley's Observatory, Bermerside, Halifax, 1899-1900: J. Gledhill.—Photographic Measures of the Ring Nebula in Lyra and of the Neighbouring Faint Stars: F. P. Leavenworth.—(1) Ephemeris for Physical Observations of the Moon for 1901; (2) Note on the Moon's Eclipse Diameter: A. C. D. Crommelin.—The Occultation of Saturn, 1900 September 3: Rev. S. J. Johnson.—Variable Stars in Star Clusters: A. W. Bickerton.—On the Disappearance from Photographic Films of Star Images, and their Recovery by a Chemical Process: Isaac Roberts.—Note on the Total Eclipse of the Sun, 1900 May 28, observed at Algiers: Rev. C. D. P. Davies.—Micrometric Measures of the Diameter of Neptune and Satellite made with the 28-inch Refractor: Royal Observatory, Greenwich.—*Probable Papers*: Stationary Meteor Radiants: an Alternative Explanation: H. H. Turner.—Photographic Observations of the Planet Eros: a Close Approach to a Small Star: F. A. Bellamy.—On the Variable Velocity of α Persei: H. F. Newall.—On the System of ζ Herculis as deduced from Micrometric Measures and Meridian Observations: T. Lewis.—Kinematograph Photographs of the Total Solar Eclipse of 1900 May 28: Nevil Maskelyne.

PHYSICAL SOCIETY, at 5.—Electromotive Force and Osmotic Pressure: Dr. R. A. Lehfeldt.—On Astigmatic Lenses: R. J. Sowter.—(*a*) On a Phase-turning Apparatus for use with Electrostatic Voltmeters; (*b*) On a Method of Measuring Power in Alternate-Current Circuits; (*c*) Note on obtaining Alternating Currents and Voltages in the same Phase for Fictitious Loads: A. Campbell.—On the Refraction of Sound by Wind: Dr. E. H. Barton.

MALACOLOGICAL SOCIETY, at 8.—Morphological and Descriptive Notes on the Genus *Cryptoplax*: H. A. Pilsbry.—Notes on a Remarkable Nudibranch from N.W. America: Sir Charles Eliot.—On the Anatomy of some Agnathous Molluscs from New Zealand: R. Murdoch.—Fate of the Type Specimen of *Voluta Roadknightae*, McCoy: W. Baldwin Spencer.

MONDAY, NOVEMBER 12.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Introductory Address: The President.—Expedition through Somaliland and between Lake Rudolf and the Nile: Dr. A. Donaldson Smith.

TUESDAY, NOVEMBER 13.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Metropolitan Terminus of the Great Central Railway: George A. Hobson and E. Wragge.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—An Improved Form of Three-Circle Goniometer: G. F. H. Smith.—A Simple Proof of the Rationality of the Anharmonic Ratio of Four Faces of a Zone: Harold Hilton.—Sulpharsenites of Lead from the Binnenthal. Part II. Rathite: R. H. Solly.

THURSDAY, NOVEMBER 15.

ROYAL SOCIETY, at 4.30.—The following Papers will *probably* be read: Further Note on the Spectrum of Silicium: Sir Norman Lockyer, F.R.S.—On Solar Changes of Temperature and Variations in Rainfall in the Region Surrounding the Indian Ocean: Sir Norman Lockyer, F.R.S., and Dr. W. J. S. Lockyer.—Argon and its Companions: Prof. W. Ramsay, F.R.S.—Data for the Problem of Evolution in Man. VI. A First Study of the Correlation of the Human Skull: Dr. Alice Lee and Prof. K. Pearson, F.R.S.—Mathematical Contributions to the Theory of Evolution. IX. On the Principle of Homotyposis and its Relation to Heredity, to the Variability of the Individual and to that of the Race. Part I. Homotyposis in the Vegetable Kingdom: Prof. K. Pearson, F.R.S.—On Retinal "Blaze" Currents: Dr. Waller, F.R.S.

LINNEAN SOCIETY, at 8.—Contributions to the Comparative Anatomy of the Cycadaceæ: W. C. Worsdell.—On a New Parasitic Copepod: Miss Alice L. Embleton.

CHEMICAL SOCIETY, at 8.—The Bases contained in Scottish Shale Oil: F. C. Garrett and Dr. J. A. Smythe.

FRIDAY, NOVEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Capacity of Railway Waggons as affecting Cost of Transport: D. Twinberrow.

CONTENTS.

THURSDAY, NOVEMBER 15, 1900.

FOSSIL PLANTS AND EVOLUTION.

Studies in Fossil Botany. By D. H. Scott, F.R.S. Pp. xiii + 533. (London: Adam and Charles Black, 1900.)

THE present work owes its origin to a course of lectures delivered at University College in 1896. In appealing to a wider audience, Dr. Scott has rendered an important service to biological science, and has placed before the botanical student some of the most striking results of palæobotanical investigation, which cannot fail to demonstrate, even to the most sceptical, the supreme value of fossil records from the evolutionary standpoint. The author expressly states in the preface that his object has by no means been to write a manual of fossil botany,

"but to present to the botanical reader those results of palæontological inquiry which appear to be of fundamental importance from the botanist's point of view."

The study of petrified fragments of Palæozoic plants has of late years contributed more trustworthy and important data towards the solution of phylogenetic problems than any other department of palæobotany. It is, however, most desirable that the student should recognise that the range of fossil botany is wide, and that results of primary importance may be reasonably expected also from investigations along other lines than those which are followed in the present work.

A word of praise is due to Mr. Gwilliam, who has drawn the majority of the admirable illustrations. After a brief introduction, the author proceeds to deal with the most important Palæozoic representatives of the Equisetales, Sphenophyllales, Lycopodiales, Ferns, Cycadofilices and Cordaiteæ; a short account is given also of Mesozoic Gymnosperms. The concluding lecture, in which the general results are summarised in a clear and convincing style, is of special interest as one of the most striking contributions towards the scientific construction of botanical genealogies that we have ever read. In the lectures on the Equisetales we have a concise account of the extinct ancestors of the modern Horsetails, more particularly of the somewhat comprehensive genus *Calamites* and of the various types of fructification included in the Calamarieæ. Lecture iv. treats of the extinct group Sphenophyllales, including *Sphenophyllum* and *Cheirostrobus*; the latter genus, originally described by its author—Dr. Scott—in 1897, is of primary importance as enabling us to connect together such apparently distinct phyla as the Equisetales, Lycopodiales and Sphenophyllales. Three lectures are devoted to the Lycopodiales. Satisfactory restorations of extinct plants are always a difficulty; that of *Lepidodendron elegans* hardly does justice to what must have been one of the most striking and beautiful trees in the forests of the Palæozoic era. Although our knowledge of the anatomy of *Lepidodendron* is in several respects fairly complete, there are still a few points on which further information is much to be desired.

Dr. Scott suggests "a certain similarity" to *Isoetes* as regards the manner of secondary growth in a Lepidodendroid stem, and refers to "considerable difficulties" presented by the phloem of the Lepidodendreæ, without dealing with these questions at length. We are, I believe, still in want of satisfactory evidence of the existence of typical phloem, which was added to by cambial activity, at least in the case of the vegetative shoots of the Lepidodendreæ. The account of the leaves of *Lepidodendron* is particularly interesting; the stomatal grooves on the lower surface of the leaf suggest a xerophytic adaptation. Indications of xerophytism are afforded by other anatomical characters in certain Palæozoic types, and we are tempted to express the wish that a lecture had been devoted to the consideration of such evidence as is available bearing on the physiology and biology of Palæozoic plants. The nature of the large scars on the well-known Ulodendroid branches is admittedly still unaccounted for; it would have been a satisfaction to have a new and carefully made drawing of the often quoted specimen, described by Mr. D'Arcy Thompson in 1880, which is considered by many to prove that the scars are the result of the mutual pressure between the bases of cones and the stems which bore them.

One of the most striking cones included in the account of various Lepidostrobi is an excellent heterosporous type, which was in all probability borne on the well-known stems known as *Lepidodendron Veltheimianum*.

In referring to the enormous output of spores necessitated by the arboreal habit of the Lepidodendreæ, an allusion is made to an exceedingly important discovery, which has not yet been published in full, of a Lepidodendroid strobilus possessing seeds. This new *Cardiocarpon*-bearing cone, which Dr. Scott has recently investigated, is of great interest, as showing that "some of the Palæozoic Lycopodiales actually crossed the frontier line which separates Sporophyta from Spermaphyta." This discovery naturally suggests an additional argument in favour of a possible connection between the Lycopodiales and Coniferæ; but, on the other hand, as we are reminded in the concluding lecture, there are difficulties in the way of connecting the Coniferæ with the Lycopods, and arguments are not wanting in favour of the view that the Gymnosperms as a whole may have had a common origin from the Filicales.

The differences between *Sigillaria* and *Lepidodendron* and the exact morphological nature of *Stigmaria* are, as the author notices, points on which further light is needed. Recent research has added enormously to our exact knowledge of numerous extinct types which were until lately unknown; it has also taught us that we have still much to learn with regard to some of the commonest fossils from the Coal-measures.

A photograph is given (p. 207) of a transverse section of a Sigillarian stem, which was briefly described some years ago by Mr. Carruthers, but it is to be regretted that no account of the anatomy of this stem has ever been published. It is unfortunately very rare to find an undoubted *Sigillaria* in which the tissues are preserved, and we would express the hope that the example referred to in Lecture vii. may not remain much longer undescribed.

In the lectures on ferns, the most important new facts are those relating to the Botryopterideæ, which are now shown to afford among the Filices a striking instance of the combination of affinities in one extinct family. The account of this family is particularly interesting.

Dr. Scott's critical and thorough investigations have

played a prominent part in supplying us with trustworthy guides, which afford the means of tracing to their common origin many divergent lines of plant-evolution. Among other genera which have thrown new light on the course of evolution, the two Cycadofilicinean types *Heterangium* and *Lyginodendron*, dealt with in Lectures x. and xi., may be specially mentioned.

It is impossible in a short review to deal adequately with all the subjects of the lectures. A few remarks might be made by way of criticism bearing on nomenclature and terminology, but this is a matter of secondary importance. The work, as a whole, has been admirably done; its value is considerably enhanced by the fact that many of the conclusions are founded on the author's personal investigations which are characterised by ability, thoroughness and sound judgment. It may be safely said that there is no source from which the botanist can gain so clear a view of the far-reaching importance of researches into the morphology of Palæozoic plants than from the volume before us. A. C. S.

PHYSICAL CHEMISTRY IN AMERICA.

The Journal of Physical Chemistry. Edited by Wilder D. Bancroft and Joseph E. Trevor. (Cornell University, Ithaca, New York.)

THE recent development of physical chemistry may be said to date from the year 1887. The fundamental ideas on which the modern superstructure rests had been conceived and even published before that time; but though the phase rule of Gibbs, the osmotic pressure theory of van 't Hoff and the electrolytic dissociation theory of Arrhenius had all appeared in print, they were buried in the little-known transactions of minor academies, and so escaped general notice. It is undoubtedly to Ostwald that the popularisation of physical chemistry is due. Himself an unflagging worker in the field, he gathered together and systematised the work done by his predecessors in the *Lehrbuch der allgemeinen Chemie*, which was completed in 1886. In 1887 the new era began with the establishment of his *Zeitschrift für physikalische Chemie.* To the first volume of this journal, van 't Hoff and Arrhenius contributed succinct accounts of those theories which have since so largely inspired and dominated physicochemical work. The extent of this work may be gathered from the fact that of the *Zeitschrift* thirty-four volumes have now been published, each volume containing on the average nearly 750 pages.

Amongst the students frequenting Ostwald's laboratory in Leipzig there has always been a large number of Americans, eager and energetic after their kind. Most were enthusiastic for the new theories, and in the best the enthusiasm was tempered by intelligent and judicious criticism, differing widely from the suspicious conservatism so often displayed in this country when these theories have been under discussion. To this happy scientific temperament we owe the fact that to-day physical chemistry is being much more thoroughly cultivated on the other side of the Atlantic than in Britain. In many, perhaps most, of the Universities it is taught as part of the student's ordinary chemical equipment, and the student who wishes to specialise in the subject can find in Boston or at Cornell ample opportunity and encouragement for study and research.

Cornell University has published since 1897 the *Journal of Physical Chemistry* under the editorship of two of its professors. On the cover of the *Journal* for March 1899 we find that the department of chemistry offers the following courses, each of which runs through the entire year.

(1) *The Phase Rule.*—A comprehensive qualitative treatment of all types of chemical equilibrium, as these are classified by the Phase Rule of Gibbs.

(2) *The Law of Mass Action.*—Non-mathematical exposition.

(3) *Mathematical Chemistry*, I.—The mathematical theories of chemical equilibrium, of the velocities of reactions, and of electrochemistry.

(4) *Mathematical Chemistry*, II.—A systematic study of Duhem's "Traité élémentaire de Mécanique chimique."

(5) *The History of Thermodynamics.*—Especial consideration is given to the physicochemical applications of thermodynamic theory.

(6) *Introduction to Mathematical Chemistry.*—An elementary exposition of the essential features of: (*a*) the theory of surfaces, as applied in geometric representations of the thermodynamic properties of bodies; (*b*) spherical harmonics, as applied in the theory of diffusion; (*c*) the principles of least and varying action, as applied to the problems of chemical and electrochemical equilibrium.

(7) *Electrochemistry.*—Historical treatment.

(8) *The Velocities of Reactions.*—Historical account and mathematical theory.

(9) *Laboratory Work.*—Laboratory methods and experimental research.

Two or three lectures weekly are given in each course, the aggregate weekly number of lectures being twenty. Certainly no German university offers a more complete or systematic course of instruction in physical chemistry than this.

As might be expected from the countrymen of Gibbs, the lecturers give a prominent place to the application of thermodynamics to the problems of chemical equilibrium. The same predilection appears in the *Journal*, to which Duhem, the chief contemporary exponent of the subject, is a frequent contributor. Electromotive force also receives a large share of attention. The reviews of books and critical abstracts of papers on physical chemistry appearing in other publications are in general well done, being brief, clear and to the point.

The personality of one of the editors is deeply impressed on the *Journal.* His views of the physical chemistry of to-day may perhaps best be seen from the following extract, taken from a notice of the new edition of Ostwald's *Grundriss der allgemeinen Chemie*:—

"Physical chemistry is not yet a quantitative science: it is a pseudo-quantitative science. There are all the outward signs of a quantitative science. We have formulas and tables; we make use of thermodynamics and the differential calculus; but this is for the most part a vain show. Long before we reach the point where the formula is to be tested experimentally, we slip in a 'simplifying assumption'; that the concentration of one component may be considered as constant; that the heat of dilution is zero; that the solute may be treated in all

cases as though it were an indifferent gas; that the concentration of the dissociated portion of a salt may be substituted for the total concentration; &c., &c. The result is that our calculations apply at best only to limiting or ideal cases, where an error in deducing the formula may be masked by the error of observation. Helmholtz did not do this, but Helmholtz is considered old-fashioned."

What Mr. Bancroft would have us do is to study concentrated solutions. The object is most laudable; but until a Helmholtz appears who is capable of attacking the problem in all its complexity, physical chemists will probably continue their work on dilute solutions, for which the conditions are comparatively simple, and the behaviour of which is represented closely by the results deduced from a consideration of the limiting or ideal cases above referred to.

There is one point about many of the reviews (and some of the original contributions) which calls for remark—they seem needlessly scathing. Should any one be so unfortunate as to differ in opinion from the reviewer, he is forthwith tomahawked, and his scalp brandished in triumph before the horrified reader. It is painful to see one's friends—nay, even one's enemies—ruthlessly butchered in this fashion, and we would earnestly counsel a less close adherence to the former methods of the Wild West. J. W.

THE EXPLORATION OF THE UPPER AIR.

Sounding the Ocean of Air. Being six lectures delivered before the Lowell Institute of Boston in December, 1898. By A. Lawrence Rotch, S.B., A.M. "Romance of Science" Series. Pp. viii + 184. (London: Society for Promoting Christian Knowledge, 1900.)

A CORDIAL welcome for this little book may be anticipated from the fact that it is the latest addition to the series which has given us Boys's "Soap Bubbles," Perry's "Spinning Tops," Worthington's "Splash of a Drop" and Sir R. Ball's "Time and Tide." Its author has won for himself a prominent place among those who are best acquainted with modern ways of sounding the ocean of air, by the work done at his observatory at Blue Hill, Massachusetts, and by his personal association with the observers of clouds and the users of balloons and kites in Europe.

Perhaps the very width and depth of his acquaintance with the details of the subject have made the task of the popular exposition of it in six short chapters a difficult one. The procession of facts, each one of great interest in itself, is apt to become panoramic and even kaleidoscopic; and when one page, or sometimes one paragraph, has to accommodate a succession of scientific ideas, the inexpert reader may find himself a little bewildered with the rapidity of the transitions, and occasionally even with some short cuts to scientific conclusions.

After a short historical introduction the book deals successively with the exploration of the upper air by means of clouds, balloons and kites. Each section gives a brief account of the earlier experiments, before treating of the recent results. The romance begins in the first chapter with a striking diagram of the heights of certain observatories, mountain peaks, kites and balloons, showing one balloon—an unmanned one, be it said—at the almost incredible height of 13 miles or more (upwards of 70,000 feet), where the corresponding barometric pressure is about one and a half inch of mercury; it culminates in the chapter describing these extremely lofty ascents. The chapters on the various types of balloon, captive balloons, free balloons and *ballons sondes* (unmanned balloons) are, both from the historic and the scientific point of view, the most interesting to the general reader. The study of clouds is clearly too large a subject for a single chapter; and the final chapters, which are devoted to the description of kites and the results obtained at Blue Hill, enter into details which the meteorologist will find of great value and interest, but which require close attention from the reader. The diagrams with which the book is illustrated have suffered a little from the reduction in scale for the purpose of reproduction; but the reader who will take the trouble to follow them carefully with the text will be rewarded by obtaining an excellent survey of the work done with kites up to a height of 12,000 feet, and some idea as to what they may be expected to accomplish in the future.

One side of the romance of kite work is only touched with a light hand. The Berlin experimenters could supply at least one thrilling story of a kite that absconded for the night with its wire, and made a long and very eventful journey; but Blue Hill has perhaps been more fortunate; doubtless its situation lends itself less easily to romantic exploits of that description.

It is interesting to notice the geographical distribution of the work of exploring the upper air as it appears in Mr. Rotch's account. Speaking quite generally, the United States are conspicuous for the work with kites, Germany for various forms of manned balloons, and France for *ballons sondes*, although the most adventurous of these last, the "Cirrus," belonged also to Berlin; while cloud work is more evenly distributed, the services of Hildebrandsson in that department render Sweden conspicuous. Great Britain is credited with an active share in the initiation or early development of the scientific exploration of the air by clouds, balloons and kites in turn, but in later years seems to have withdrawn from such enterprises.

Mr. Rotch's interesting lectures may well leave the impression that the further sounding of the upper air of the British Isles might be exciting on account of the special situation and circumstances of the islands, but, for the same reason, would be of great scientific importance.

OUR BOOK SHELF.

The Locust Plague and its Suppression. By Æneas Munro, M.D., Edinb. and Cordova, Fellow of the Faculty of Physicians and Surgeons of Glasgow. With illustrations. Pp. xvi + 365. (London: Murray, 1900.)

THE volume before us has been prepared by the author after nearly ten years' observation of locust ravages in the Argentine Republic and in South Africa. He is profoundly convinced of the enormous damage caused by locusts in various parts of the world, and has brought together a considerable amount of information respecting the various means which have been adopted for destroying them. Dr. Munro writes from a practical point of view,

and treats the locusts of different countries as, to all intents and purposes, the same insect. His book will no doubt be very useful to agriculturists in countries infested by locusts; but he scarcely allows for the variations in habit which exists between different species. For instance, he observes that the South American locusts are said to breed on the shores of certain lakes in Bolivia, and asserts that if they could be destroyed in this locality they would be exterminated from the whole of South America (!). It is hardly possible to take such a remark seriously; but we may perhaps observe that even if the story were true, it could only be true of one or two species at most. It is also suggested that ophthalmia in Egypt (well known to be spread by flies) may be caused by locusts.

Dr. Munro also claims that his book is the first on the subject; but we are more inclined to think that a locust bibliography would fill a book as large as his own. Besides, some of his illustrations appear to be taken from American works.

An interesting account is given of the appearance of what is called the "new" locust in South Africa, and he quotes from Mr. Péringuey: "The present species was very closely allied to *Acridium peregrinum*, and in the same way that that species had swarmed into Algeria after the myriads of a smaller locust, *Stauronotus* (not *Jauronotus*, as printed) *marocanus*, had been destroyed at great expense, this present species was following in the rear of a smaller locust, *Pachytylus migratorius*" (§ 166). One curious point is that the "new locust" is said to be unwholesome, if not actually poisonous, by the natives. However, in § 32, under the heading, "Scientific Definition," we read, "the locust we have here (in Africa) is, to all intents and purposes, the same insect called technically the *Acridium peregrinum*, *Locusta migratoria*, or the wandering locust" (Fig. 4*a*, p. 37). Here it will be seen that two species, by no means closely related, are spoken of as if they were the same; and on turning to p. 37 we find two figures of locusts, specified as "The African Locust" and "The South American Locust," as if there was only one species in each continent.

The book is very diffusely written, and treats of a great variety of subjects, some of them rather irrelevant to the locust question. It is, however, divided into 900 numbered paragraphs, and provided with an excellent index, which will make it a useful book of reference, though it would be rather a formidable undertaking to read it through from cover to cover.

Leçons d'Anthropologie Philosophique, ses Applications à la Morale Positive. Par D. Folkmar. Pp. xiv + 336. (Paris: Schleicher Frères, 1900.)

SCIENCE exists for the sake of something beyond itself. Doing, not knowing, is what determines the place and significance of any body of doctrine in the hierarchy of arts and sciences. The synthesis of the human sciences in the light of their worth for action is not effected by sociology. This fails to include certain individual sciences. In this way Prof. Folkmar makes the transition from the sociological studies, which engrossed him at Chicago, to the philosophical, as opposed to physical, anthropology, which he expounds from his chair at Brussels.

The changed point of view involves an endeavour after a new classification of the sciences of man, a critical determination of the limits of those sciences as hitherto pursued, and a sketch of the unifying conceptions that involves disquisitions psychological, anthropological in the narrower sense, and ethical. To the practical applications of his teaching Prof. Folkmar proposes to devote his life.

Dr. Folkmar may be described as Spencerian, though critically so. He rests much on Letourneau, and has studied in the following of Giddings, Lester Ward and other of the "new sociologists." He owes something to Guyau. He exhibits on the whole a sober judgment, and is frequently suggestive in his treatment even of well-worn topics. It is therefore the more to be regretted that he has almost buried good work among platitudes, second-hand matter and pretentious technical phraseology, doubtfully permissible in his *conférences* and inadmissible in the *litera scripta* meant to endure.

Terms such as *anthropographie* (of which different misprints occur, pp. 71, 72), *archéographie* (which means ancient geography), and *praxéologie* detract from the merit of Dr. Folkmar's graphic representation, upon the faces of a cube, of the sciences of man. His much use of the word "innervation," defined as meaning simply "a form of vibration of the nervous tissues," is a weakness of the same kind. Nothing, surely, is gained by declaring the question of the unitary origin of the race to be "on ultimate analysis the question of monogenism *versus* polygenism" (p. 127).

More serious in a work of scientific pretensions is what we take to be a missing of the main point with regard to polyandry in the remark (p. 188) that where it obtains many women must needs remain unmarried. That completeness of life can be determined with mathematical exactness (p. 319) needs proof. In an otherwise ingenious suggestion for a grading of scientific asseveration "impossible" (p. 67, line 24) *is* impossible, and "improbable," which is not improbably the right reading, will not balance the "probable" which has preceded.

In fine, though Dr. Folkmar's ability to supply a text-book of anthropology as he conceives it will not admit of question, and an essay from his pen developing, say, the conception which he would substitute for Mr. Spencer's ethical ideal might prove instructive, his present book suggests the high-class amateur who enters for the first time in a tournament of masters.

H. W. B.

The Principles, Construction and Application of Pumping Machinery. By Henry Davey. Pp. xvi + 295; 250 illustrations. (London: Charles Griffin and Co., Ltd., 1900.)

THE purpose of this book, as stated by the author, is to present information on pumps and pumping machinery in such a form as to make it useful to the practical engineer engaged in the application of pumping machinery in mines and for waterworks, or in other positions where large quantities of water have to be dealt with. This purpose has been fairly accomplished. The information given is of a thoroughly practical character and made plain by numerous illustrations, and the book cannot fail to be of great use either to the student seeking information or to the practical engineer engaged in works requiring pumping machinery.

The first chapter contains an interesting summary of the gradual development of pumping machinery. Cornwall may be said to be the land of the birth of large pumping installations. It was here that both Savery and Newcomen brought into use the power of steam for raising water from the mines, and their engines remained in use until Watt introduced the system of a separate condenser. It is not much more than a century and a quarter ago that Boulton and Watt commenced the manufacture of their engines for the coal-mines in Staffordshire and Warwickshire, but it was Cornwall that afforded the great field for the development of Watt's inventions. The progress of this development is interesting. The coal-mines were becoming deeper and very costly to drain. The proprietors were unwilling to incur the expense of removing the old atmospheric engines put down by Newcomen; and to meet this difficulty Boulton and Watt erected many engines at their own expense, taking as payment one-third of the

saving effected in raising the coal. At one mine where three of Watt's engines were erected the proprietors engaged to pay 800*l.* a year for each engine as a compromise for the third part of the saving in coal.

It was with the Cornish engine that the principles governing steam engine economy were first grappled with; and with the engines used for all purposes on land, pumping engines, even at the present day, are worked with the greatest economy of fuel, examples being given where the engines are worked with an expenditure of less than 2 lbs. per I.H.P. It is interesting to note the change of pressure at which steam is worked now, reaching to 150 lbs. on the square inch, as compared with the 5 lbs. used in many of the old Boulton and Watt engines. These engines were not confined to pumping water from mines, but were applied to reclamation purposes, many of the Boulton and Watt engines, made a century ago, being still in use in the fens of Lincolnshire and Cambridgeshire. These machines were noted for their massive construction and the excellency of the workmanship, as attested by the number of years during which they have done good service.

The other fourteen chapters into which the book is divided deal with descriptions of the various types of pumping engines in use; pumps and pump valves; pit work; shaft-sinking; hydraulic transmission of power in mines; valve gears; waterworks engines; trials of pumping engines; centrifugal and low lift pumps, with descriptions of some of the scoop wheels in use in Holland; hydraulic rams and pumping mains.

Elements of Hydrostatics. By S. L. Loney, M.A. Pp. viii + 248 + xii. (Cambridge: University Press, 1900.)

"ELEMENTS OF HYDROSTATICS" is a subject the limits of which are sufficiently well known to require little definition. In the present instance it includes a fairly complete treatment of centres of pressure of rectilinear areas and circles by what used to be called, at Cambridge, "three-day methods"—also sections on rotating liquids and on tensions of vessels and curves of buoyancy. The book will do admirably for the ordinary run of students preparing for examinations in this subject, and the copious problems and examples should commend it to science students; but there are one or two points in which improvement is desirable. "Whole pressure" has been too long a fetish of the third-rate schoolmaster, who "thinks he is wise when he is not." But instead of banishing this misleading idea to a few lines of small print (or, better, omitting it altogether), and replacing the term "whole pressure" elsewhere by "*resultant thrust* on a *plane* area," Prof. Loney makes confusion worse confounded by speaking, so far as we can make out, indiscriminately of "whole pressure," "whole pressure or thrust" and "whole thrust." Again, there is no reason why we should be left in the dark as to the precise distinction between a perfect fluid and an ordinary fluid, or the reason why the principles of hydrostatics apply with sufficient approximation to the latter; these points are hinted at, but might with advantage be stated more explicitly. The usual figure of the air-condenser, with its valves hanging in an impossible position, is once more reproduced.

There are, to our knowledge, many highly successful teachers who, in their ignorance, persist in their preference for misleading methods of dealing with such notions as "whole pressure," the "parallelogram of velocities," the "binomial theorem" and the like. There are few writers better qualified to prove that scientific accuracy is not incompatible with a successful text-book than Prof. Loney, whose name alone is sufficient to ensure a large circulation for his works. Why, too, does not the Cambridge University Press rise superior to pandering to the fancy of those mathematical masters who know no better?

Minéralogie Agricole. By F. Houdaille. Pp. 299, avec 107 figures dans le texte. (Paris: Félix Alcan, 1900.)

THE object of this little work is to provide agriculturists and others with a knowledge of the properties, physical and chemical, of the minerals important to man, either as constituents of rocks and soils, as fertilisers or as sources of materials used in the arts. The author assumes ignorance of physics, chemistry and crystallography on the part of the reader, and as the descriptive portion of the book would be unintelligible without some knowledge of these subjects, he attempts to give the necessary smattering in an introduction of eighty-nine pages. The laws of crystallography and modern views of crystal structure are dealt with in forty pages, illustrated by a number of indifferent figures, some of which, notably the rhombohedron of Fig. 8, entirely fail to produce on the eye the effect which the author presumably intended. In the chemical section the old equivalent notation is preferred to that usually accepted at the present day; thus, sodium carbonate receives the formula NaO,CO_2+10HO! A considerable portion of the space devoted to analysis is occupied by a picture of an elegant gentleman puffing languidly with a blow-pipe at a long candle fixed in an equally tall candlestick. The rest of the book contains a selection of facts about minerals which can be found in any treatise on descriptive mineralogy, together with some useful information as to methods of determining the permeability of soils and the percentage of calcium carbonate contained in them. We fear, however, that the work will hardly be found readable by any one who has not already had an extensive training in chemistry and mineralogy. It is therefore unlikely to be of much value to the class for whom it appears to be intended, nor can it be recommended to the serious student.

Engine-Room Practice. A Handbook for the Royal Navy and Mercantile Marine. By John G. Liversedge, R.N. Pp. xi. + 292. (London: Griffin and Co., Ltd., 1899.)

MR. LIVERSEDGE'S handbook will be found by all engineers to be a very useful supplement to the more technical treatises of Mr. Seaton and of Messrs. Sennet and Oram. It lays down the whole duty of a marine engineer, and more particularly of a naval engineer, from the day when he receives notice of his appointment; and it is throughout well-written, full, and admirably to the point. The running of the main engines and the care of the boilers are, of course, the chief concerns of the book; but the auxiliary machinery is also well looked after, and there are separate chapters on the electric light, the hydraulic, the refrigerating and the air-compressing plants. The chapter on adjustments and repairs seems to us of especial value, for while a successful repair at sea is often the outcome of what seems an inspiration, its success may at any time be assured by a knowledge of what has been done in similar cases.

We could wish, especially in the present season of divergent opinion on the matter, that the water-tube boiler had received somewhat greater attention. A few pages at the end of the book are specially contributed by Fleet Engineer Edwards, of H.M.S. *Powerful*, and perhaps it were unwise to do more until fuller experience has been gained; but we may expect to see the matter thoroughly taken up in later editions, for no unprejudiced observer can doubt that the water-tube boiler, in one form or another, has come to stay.

While Mr. Liversedge's book is primarily a professional handbook, it will be found, at the same time, to interest all who have any acquaintance with the engineering side of naval life, even though they may have but a superficial knowledge of the ordinary equipment of a ship's engine-room.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Markings of Antilocapra.

IN NATURE of Oct. 11 (p. 586) Mr. R. J. Pocock says: "If the American prong-buck were an inhabitant of Africa, I presume that its conspicuous patterns . . . would be cited as evidence supporting the theory of recognition marks. But in the prairies of the United States there are no species that resemble it in size and form, so as to create confusion as to identity."

The prong-buck is so cited by Wallace ("Darwinism," p. 218), and a figure is given (p. 219) of a similarly-marked gazelle in support of the same theory. But the point of the whole matter rests on the aid given to the members of a herd in following one another, and has nothing whatever to do with the presence of allied species. I cannot understand how Mr. Pocock, who appears to have read Wallace's work, can have overlooked the point of the argument so completely. I have had the pleasure of seeing herds of prong-bucks (*Antilocapra*) in their native wilds (Pecos Valley, and near the Sacramento Mountains, New Mexico), and can readily understand how useful the markings must be in helping the animals to keep together in the dusk or dark, whereas it is not at all probable that they expect to escape observation on the open prairie by daylight. If these animals lived singly, there might be some plausibility in "Thayer's principle," as applied to them, but in herds they can be seen from afar off, and the same must be true of the African gazelles. Their safety is in flight, not inconspicuousness, and the necessity for keeping together when in flight is obvious.

The coyote or prairie-wolf (*Canis latrans* and allies), which also lives on the prairies and is gregarious, has the habit of barking incessantly at night, and this doubtless serves the same purpose as the markings of the prong-buck.

It might conduce to clearness if we divided what are now called recognition-marks into two categories, thus:—

(1) *Recognition-marks*, which assist members of a species in distinguishing their fellows from other species.

(2) *Guide-marks*, which assist members of a species in following one another. The markings of the prong-buck would then come under the head of guide-marks. T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A. October 30.

Curves without Double Points.

MR. BASSET'S objection to the term "non-singular" (see NATURE, Oct. 11, p. 572), arises from a misunderstanding. The ordinary use of the term by English-speaking mathematicians is natural and legitimate; it is applied to curves without double points when the curve in question is defined by a relation among the coordinates of its points. In the case of a curve defined in another manner, for instance by a tangential equation, "non-singular" could not possibly be used in the sense. In fact, the phrase which Mr. Basset denounces as "exceedingly infelicitous and misleading" is one which, standing by itself as Mr. Basset quotes it, strikes a geometrician as unfamiliar; "non-singular cubic curve," "non-singular curve of the nth order," are familiar to him, and are unobjectionable.

In the study of algebraic curves the word *node* is in common use to denote any double point; if it is necessary to distinguish the three chief kinds of double points, the words crunode, acnode, cusp are recognised; and, although the two first are not wholly satisfactory, yet their meaning is unmistakable. Further, we have adjectives nodal, crunodal, cuspidal, binodal, etc. If Mr. Basset's mode of investigation is such that the introduction of new technical terms is really unavoidable, may I suggest that the phrase *nodeless curve* concisely describes a curve without double points? HERBERT RICHMOND.

King's College, Cambridge, November 10.

Euclid i. 32 Corr.

HAMBLIN SMITH writes, these "corollaries were first given in Simson's edition of 'Euclid'" (edition 1872, &c.). J. Walmsley, "Introduction to Geometry" (1880, &c.), styles them Simson's corollaries. Hall and Stevens say these "theorems were added as corollaries to Prop. 32 by Robert Simson" (1888, &c.), and finally, Loney, in his edition of Todhunter's "Euclid," writes, "the corollaries were added by Simson." Many years ago it was pointed out to me that these corollaries, with many interesting applications, were given by Clavius in his edition of the Elements (1607), see pp. 105–108. On p. 107, he cites "ex Campano, si pentagoni singula latera producantur in partem utramque, ita ut quælibet duo extra pentagonum coeant, efficientur quinque anguli ex lateribus coeuntibus æquales duobus solum rectis." Clavius probably is not the first publisher of these results. R. TUCKER.

November 5.

Late Appearance of a Humming-bird Moth.

IN a garden in Lower Addiscombe Road (well in the town of Croydon), I saw a humming-bird hawk-moth to-day sporting over a bed of scarlet geraniums. It was as fresh as if newly emerged. This is the first time I have seen the insect so late in the year. Would it not have been called a "late appearance" even a month ago? It testifies strongly to the unusually open autumn here. J. EDMUND CLARK.

Lile Garth, Ashburton Road, Croydon, November 3.

SOME RECENT ADVANCES IN ZOOLOGY.

TO take stock from time to time of the progress made in its different branches is advantageous in the case of every science, but in none more so than in zoology, where specialisation is now carried to such an extent that the workers in one section have in general but little acquaintance with what their brethren are doing in another. This same subdivision of work renders it, however, extremely difficult for any single writer to give any adequate account of what has been effected during the last year or two in all the different branches of the science, the difficulty being enhanced by the circumstance that the one for 1898 is the latest volume of the "Zoological Record" that has at present been published. All that can therefore be attempted in the present article is to give a fairly full *résumé* of the more notable advances in the branches of zoology with which the writer is best acquainted, and to make mention of such discoveries in other sections of the subject as may have come under his notice.

Among the Mammalia, by far the most important discovery made of late years is the identification by Mr. J. P. Hill, of Sydney, of the existence of a rudimentary placenta in the Bandicoots (Perameles). From this it has been inferred that all Marsupials originally developed a placenta, which has become abortive in the more specialised members of the group. This discovery entails, almost of necessity, a modification in the generally accepted classification of the Mammalia. And instead of dividing the class into the three equivalent groups, Eutheria, Metatheria and Prototheria, Prof. H. F. Osborn has suggested that we should now take only the two divisions of Eutheria and Prototheria; the former being subdivided into Placentals and Marsupials, and the latter (as heretofore) including the Monotremes alone. Placentals and Marsupials may indeed be now regarded as divergent branches of a single stem; the latter being less primitive than are the Insectivora. On the other hand, Monotremes are so different from Eutherians that some zoologists even go so far as to consider them derived independently from Reptiles or Amphibians. In this connection, as tending to emphasise the intimate relationship between Marsupials and the primitive Carnivora, reference may be made to a paper by the present writer (*P.Z.S.*, 1899), in which it is attempted to show that both have a similar dental formula. It may be added that our knowledge of the anatomy of the Monotremes has been largely increased by the publication of the results of the work on the specimens collected by Dr. Semon, now in course of publication in the *Jenaische Zeitschrift*. Moreover, much interest

attaches to the account recently given by Herr Sixta of the precise manner in which the female Duckbill supplies her newly-hatched young with milk.

A special feature of the last year or two is the application of American modes of collection and investigation to the smaller mammals of Europe and Asia, with the result that a number of more or less well-defined local races have been established in the case of many familiar European species. Admirable examples of this style of work are afforded by Mr. Barrett Hamilton's studies of the Voles, Dormice, Squirrels, Harvest Mice, and Variable Hares of Europe and Asia. Attention may likewise be directed to the same gentleman's investigations with regard to the colour-change which takes place periodically in many northern mammals.

Till recently the Edentates of South America have been regarded as a totally isolated group; but the material obtained in the Tertiaries of North America has enabled Dr. Wortman to state confidently that they

FIG. 1.—A flightless representative of the Scale-tailed Squirrels (*Zenkerella insignis*). (From Mr. De Winton's figure in the *Proceedings* of the Zoological Society for 1898.)

trace their origin from the Eocene group Ganodontia, as represented by Calamodon and Psittacotherium. The Rodents, too, have been brought into closer touch with more typical mammals by the discovery of their near relationship to the Eocene Tillodontia.

As regards systematic work, the discovery of a new Snub-nosed Monkey (*Rhinopithecus bieti*) in the upper valley of the Mekong is as interesting as it is unexpected; while of far more morphological importance is the description of a flightless representative of the African Scale-tailed Squirrels (Anomaluridæ), for which the name Zenkerella must be adopted. Of even greater interest is Prof. Ray Lankester's discovery (not yet published in detail) that the Bear-like Æluropus of Tibet has no close affinity with the Ursidæ, but is a near relative of the Raccoon-like Panda (Ælurus). Neither have the relationships of extinct forms been neglected, Dr. Major's discovery that the European Lemuroid Adapis agrees in the structure of the tympanic with the Malagasy Lemurs (and with them alone) being of great significance. The same writer's description of additional remains of the extinct Malagasy genera Megaladapis and Nesopithecus throws further light on the specialisation of the Lemuroids, and the apparent parallelism of the latter to Anthropoids. Here brief reference must also be made, even if all his conclusions be not accepted, to Prof. Hubrecht's investigations on the placentation of the Lemuroid genus Tarsius and its relationship to the higher Primates.

Reverting to extinct forms, it has to be mentioned that, apart from its other points of interest, the discovery of a portion of the skin of a Ground Sloth (Glossotherium) in Patagonia has revealed the unexpected fact that the ossicles with which the hide of these animals has long been known to be furnished are situated on its inner instead of its outer surface; the latter carrying a thick coat of long coarse hair.

The discovery some years ago that Wapiti occurred in Central Asia served to call attention to the similarity between the faunas of that region and North America, and the links between the two have now been drawn closer by the description of a species of the American Jumping Mice (Zapus) in Siberia. Another fact of importance from a distributional point of view is the discovery of representatives of the African Hyraces (Pliohyrax) in the Pliocene deposits of Samos and Greece, and apparently also in the Tertiaries of South America. And these discoveries promise to give rise to much discussion as to whether Africa or North America has been the main feeder of South America in the introduction of its fauna. With this is closely connected Prof. Osborn's suggestion that Africa has formed a great creative and dispersive centre of its own.

Mammals cannot be dismissed without a brief reference to the American "Report on the Fur-Seals of the Pribiloffs," which has added very largely to our knowledge of those animals and the diseases to which they are subject; while, it may be hoped, it will serve eventually to suppress altogether pelagic sealing.

Turning to Birds, perhaps the most important work (apart from the description of species and races, to which it is impossible to allude in detail) that has been done in England is by Mr. W. P. Pycraft, who has contributed a number of valuable papers on avian osteology to the *Proceedings* of the Zoological Society, as well as communications to other serials dealing with the general morphology of various groups of the class. Of the former papers, the most important is the one on the skeleton of the Penguins, in which it is shown that these birds are less aberrant than has been often supposed, and that their nearest relatives are the Petrels on the one hand, and the Grebes and Divers on the other. But of even greater value are the same author's observations on the morphology of the Owls (*Trans.* Linn. Soc., 1898), since they serve to indicate how many alterations will be necessary, even in avian genera, when pterylosis and internal characters are allowed their full weight in classification. The remarkable feature of "aquintocubitalism" in the bird's wing has likewise been elucidated by Mr. Pycraft in a paper published in the *Journal* of the Linnean Society for 1899; Mr. P. C. Mitchell having also written upon the same subject. The recent discovery of a new genus of Eagle (*Pithecophaga jefferyi*) by the late Mr. J. Whitehead in the Philippines is also decidedly worthy of mention. Of wider interest is the description by C. W. Andrews, in the *Transactions* of the Zoological Society, of the skeleton of the remarkable giant extinct bird from the Tertiaries of Patagonia, known as *Phororhachus*. This extraordinary bird is noticeable on account of the disproportionately large size of its skull, more especially the beak; and

when the peculiarities due to this specialisation are discounted, its affinities appear to be with the Seriema and Trumpeter of Brazil. It is, in fact, a gigantic representative of that group, occupying the same position in regard to its living allies as is held by the extinct Glyptodons and Ground-Sloths of the same continent to the modern Armadillos, Sloths, and Anteaters.

Among works dealing with avian faunas which have appeared recently, two have a special claim for mention on this occasion; the one being Dr. A. B. Meyer's "Birds of Celebes," and the other the late Mr. A. C. Stark's "Birds of South Africa." Both of these important works have received detailed notice in these columns.

From a distributional point of view, undoubtedly the most important discovery that has been made of late years among Reptiles is the determination of remains of the Australian Tertiary Chelonian genus Miolania in the Patagonian deposits, which was announced last year in this journal by Dr. H. P. Moreno. It serves not only to emphasise the evidence which has been adduced from other sources as to a former land connection between Australasia and South America, but also indicates that the strata in which its remains occur must be comparatively modern. Of very high morphological value are Mr. A. Dendy's observations (*Q.J. Micr. Soc.*, 1899) on the parietal eye of the New Zealand Tuatera (Sphenodon), in which evidence is brought forward to show that this organ was originally double, and that the single eye that now persists in a rudimentary condition is the left one of the primitive pair. In connection with this subject attention may be here directed to the remarkable discovery, made by Mr. H. M. Bernand, that in the Amphibia the cones of the retina of the eye, instead of being separate sensor organs, are merely stages in the development of the structures known as rods. But we have still another word to say with regard to the Tuatera, Prof. G. B. Howes having been recently engaged in working out the development of the skeleton in the embryo, and having had the good fortune to hatch specimens in this country. From his own researches, and those of Mr. Dendy, it is now known that there were three pairs of incisor teeth in the young state, and also that an amniotic tube was present, and that the olfactory passages became occluded during development.

Among Fishes several discoveries and observations of first-class importance have been made during the last few years, in addition to much systematic work. The discovery of a new species of freshwater fish belonging to the genus Galaxias at the Cape may not appear a circumstance of much importance, but it really forms one more link between the faunas of South Africa, Australasia and South America; the genus having previously been known only from the two regions last named. Allied to this genus is the family of African Beaked Fishes (Mormyridæ), hitherto known only by numerous species of the typical genus Mormyrus, and one of the very distinct Gymnarchus. The careful exploration of the fauna of the Congo by the officials of the Free State has, however, led to the discovery of the existence of a very large number of distinct generic types of this very curious family, all of which have been examined and described by Mr. G. A. Boulenger. The first living examples of the Bichir (Polypterus) have also been recently brought to this country, and much information has been at the same time acquired with regard to its mode of life and development. Of still more importance are Mr. J. G. Kerr's observations on the external features in the development of the South American Mud-fish (*Lepidosiren paradoxa*), which were communicated to the Royal Society in the spring of 1899. The young larvæ of this fish, which are tadpole-shaped, have very large external gills, and also a cement-organ very similar to that of embryo frogs, and Mr. Kerr was much struck with the extremely amphibian characters of the larvæ at an early stage of their existence. Among new forms special interest attaches to the discovery of a Shark (*Mitsurikina owstoni*) in Japanese waters, which indicates not only an entirely new generic type, but also, according to its describer, Dr. Jordan (*Proc.* Californian Academy, 1898), likewise a distinct family, whose nearest relationships are with the Carchariidæ. Equally interesting is the discovery in Chili of a new generic type of Lamprey (*Macropthalmia chilensis*), which was announced in 1897. The importance which Dr. Gaskell, in his papers on the origin of Vertebrates, attaches to larval lampreys from a phylogenetic point of view renders the discovery of a new member of this group full of possibilities.

It is too early at present to speak of the discoveries which are likely to occur from the detailed examination of the fishes of the Nile which is now in progress, but reference must be made to those from Lake Tanganyika, described by Mr. Boulenger (*Trans.* Zool. Soc.) in 1898. Although these yielded several new generic and specific types, they were in no wise comparable to the molluscs in general interest.

These latter, as is now well known, exhibit a remarkable resemblance in the form of their shells to certain Jurassic Gastropods; a resemblance which has led Mr. J. E. S. Moore, the energetic explorer of its waters, to suggest that the lake was formerly in direct communication with the sea, and that its so-called "halolymnic" fauna is of marine origin. Some support to this theory may possibly be found in the recent discovery that a peculiar type of Jelly-fish is one of the inhabitants of the lake.

Three other discoveries among Invertebrates call for special mention; one of these being the demonstration by Dr. Pelseener that adult bi-valve molluscs may possess true cephalic eyes, and the second the dredging in Indian waters of a hermit-crab (*Chlaenopagurus andersoni*), whose caudal extremity is protected by a bag formed out of a compact colony of small sea-anemones—truly a most extraordinary example of commensalism. The third discovery is that of a new member (*Harrimania*) of the group of Chordate Worms, or *Enteropneusta*, on the Alaskan coast, to which reference has been recently made in these columns.

So far as the interests of the human race are concerned, all other recent zoological discoveries are eclipsed by the investigations which have led to the demonstration of the relations existing between mosquitoes of the genus Anopheles and malaria. A definite statement that malaria is propagated by these annoying insects was made by Dr. B. Grassi (*Rend. Ac. Lincei*, vii. p. 234) in 1898, with due acknowledgment of previous suggestions on the subject; and since that date the columns of this journal have borne testimony to the zeal and care with which the work has been carried on, and the decisive results which have been obtained. In connection with this subject, brief mention must be made of the discovery of the generative elements in the intracorpuscular amœba-like bodies known as Hæmamœbidæ, which occur in the blood of certain animals and give rise to malarial fever, as well as in the allied Coccidiidæ, which are parasitic in Cuttle-fish. As is shown in two papers published in the July number of the *Quart. Journ. Microscopical Science*, sexual conjunction, or "zygosis," occurs among these lowly organisms; spermatozoa being represented by "microgametes," and ova by "macrogametes."

Finally, some reference must be made to the important work on distribution which has been accomplished during the last few years. In this connection it will suffice to refer to Mr. R. F. Scharff's "History of the European Fauna"; to Mr. W. L. Sclater's papers on the "Geography of Mammals," first published in the *Geographical Journal*, and reproduced in volume form with much

additional matter; to Dr. P. Matschie's "Geographische Fragen aus der Saugethierkunde," published in 1896; to Mr. R. I. Pocock's "Geographical Distribution of the Arachnida," which appeared in *Natural Science* for 1899; to Dr. Max Weber's paper on the "Origin of the Fauna of Celebes" (*Ann. Nat. Hist.*, 1899); and, lastly, to Prof. H. F. Osborn's "Correlation between Tertiary Mammal Horizons of Europe and America" (*Ann.* N. York Acad., 1900). In several of these papers special stress is laid on the evidences of connection between the faunas of the southern continents which have been steadily accumulating during the last few years; while, as already mentioned, Prof. Osborn's communication is notable on account of his theory as to the indigenous origin of the African fauna. In another part of the world a most important change in the limits of two geographical regions has been suggested (first by Mr. Sclater and then by Dr. Weber), by the transference of Celebes from the Australian to the Oriental region. If this change, together with a similar transference in the case of Bali and Lombok, which has been advocated (partly on the suggestion of Dr. Blanford) by the present writer, be generally adopted (and it seems inevitable), we have to bid farewell for ever to the almost classic "Wallace's Line," as being one of those hypotheses which, although useful in their day, were not destined to immortality. R. L.

INSTRUMENTS OF PRECISION AT THE PARIS EXHIBITION.

"AT the commencement of the nineteenth century, the French and English makers of scientific instruments were far in advance of the Germans. True, the eighteenth century knew of prominent mechanicians . . . yet the French and English makers took the lead so as almost to supply the world's entire demand in scientific instruments. This predominance had the further consequence of causing young Germans to emigrate to France or England in order to thoroughly master their subject. Many a German mechanic of to-day owes to French or English masters a substantial portion of his knowledge. The prominence of the French and English instrument makers was mainly due to the support which, in both countries, the State bestowed upon technical art." . . . "In Germany it is only within the last twenty or twenty-five years that the State has espoused the interests of the home industry in scientific instruments; but such have been the efforts and the results, that her position has, at a blow as it were, changed in favour of Germany."

These words are taken from the special catalogue of the joint exhibition of German mechanicians and opticians at the Paris Exhibition, which claims, and claims with truth, "that in this department Germany occupies now a foremost position." As to the excellence of this joint exhibition, it is difficult to speak too strongly; rumour says that some, at least, of the judges wished to award it a Grand Prix among the nations. Had the rules of the Exhibition allowed it, such an award would have met with the universal approval of all physicists who have visited Paris.

Another brief quotation from the preface will explain the position more clearly. "After witnessing," the writers say, "the steady development of our mechanical and optical trade, we cannot but look with gratification upon the practical demonstration, at the Paris Centenary Exhibition, of the flourishing state of the scientific instrument trade in Germany; and a characteristic feature of the latter is the unity of its aims, which is traceable to the history of its development and to its ultimate connection with pure science. It appeared, therefore, desirable to depart from the usual custom of grouping the exhibits under various firms, and to place them in sections embracing certain classes of instruments, so as to demonstrate on broad lines and, as a whole, within a well-arranged though condensed area, the present position of German mechanical and optical art."

Accordingly this was done under the auspices of the German Association of Mechanicians and Opticians, and, with the help of the authorities of the Reichsanstalt and of the Standardising Commission, a most remarkable exhibit has been arranged; a catalogue has been prepared, covering some 250 small quarto pages, well illustrated, with a full account of the various instruments and references to sources of further information. This is published in German, French and English—why the English edition is printed in German type is perhaps somewhat of a mystery—and issued freely to visitors who wish to use it.

The preface to this catalogue, from which the above extracts are taken, gives an interesting account of the growth of this industry, from which it appears that in the last ten years the annual value of the instruments exported, including the optical glass used for lenses, has risen from something over 200,000*l.* to over 700,000*l.*

The general exhibition is arranged in ten sections, with various subsections; the special exhibit of the Reichsanstalt forms an eleventh section to itself. In each of these sections or subsections the exhibits of each maker form a class to themselves.

Thus Section V., optical instruments, has seven subdivisions. The exhibit of Carl Zeiss, for example, appears in five of these, as well as in Section II., astronomical instruments. By means of the table of contents and list of exhibitors, it is easy for a visitor to find either the apparatus of a special class or the exhibit of a particular firm as he will.

Section I. contains metrological and standardising apparatus, and here the exhibit of the Normal Aichungs Commission is most striking. The Commission is presided over by a director, and includes, we are told, three Government councillors, twenty-four technical officials, and ten clerks; the annual expenditure is 8500*l.* Contrast this with the staff of our Standards Department, and its expenditure, according to Whitaker, of 2877*l.* Specially noteworthy, perhaps, among the exhibits of the Aichungs Commission are the model of their great comparator, and the vacuum balance made by Stückrath for comparing masses from 200 grammes to one kilogramme. But a detailed description of the catalogue would take too much space, and would indeed be of no great value to a reader; the book itself will prove to a physicist a well of useful information; the exhibit, however, must be seen in its entirety if we wish to realise what our German cousins have done.

Not that the sight is one which brings great pleasure to an Englishman, and if he moves on to examine the English exhibit his thoughts cannot fail to be very grave. There is nothing which can be compared with the German show; some well-known firms have won well-deserved prizes; there are some few interesting pieces of apparatus from South Kensington, and here and there in the electrical department one comes across a case of instruments. For the rest, the visitor will find, not collections of scientific apparatus, but small portions—attractive portions, it is true, in many cases—of the windows of well-known opticians' shops. As much apparatus as is possible is packed together in a small space, there is much repetition, there is no organisation, there is no attempt to instruct the learner or to attract the man who comes with inquiries with a view to purchase; English mechanics and opticians have no unity of aim, and their art, with some few exceptions, is but loosely linked to pure science.

A visitor who visits Paris to look for the most recent forms of scientific apparatus must have the conviction

forced on him that it is to Germany he must go for his goods.

And the conviction is strengthened by the organisation provided for giving information as to the goods exhibited. The German exhibit is under the skilled care of Dr. Robert Drosten, with some three or four scientific assistants. One or more of these gentlemen is always ready to give information about special instruments. When I visited the exhibition I asked for a catalogue, and inquired if I could examine more closely certain special instruments. By all means, was the reply, and Herr Drosten gave me several hours of his time opening cases, taking apparatus out, looking up special catalogues, and loading me with information. At the end of this time we were both tired, and he suggested that if I found, on looking over the catalogue and my notes, that I had omitted anything, I should come again. I returned next morning, and spent nearly as long a second time.

Or take, again, my own experience with the splendid exhibit of comparators and dividing engines of the Société Genevoise des Instruments de Précision.

There was a notice in the case that M. Schwartz, at the Bureau, would give information. On asking for M. Schwartz, and explaining that I wished to examine certain things with care, he came at once, opened the cases, and answered my many questions in the most courteous manner; some information which I wanted as to certain instruments not made by the Society he could not give me. It has since been sent me, at his request, from Switzerland.

So also with some American measuring and testing apparatus; the cases were opened, and I was allowed to handle the apparatus; one gentleman gave me a very full demonstration of the use of a new testing machine, which combines a multitude of ingenious devices.

Contrast this with the English exhibit; a courteous commissionaire was, when I saw it, in charge of the whole; there were some notices as to where to apply for price lists of some of the firms exhibiting; the nearest approach to a catalogue was a set of cards hung on the wall relating to the excellent exhibit of the Scientific Instrument Company. These I found of real value, but they could not be carried away for reference.

Again the same conclusion is forced home; the Germans have organised their exhibit and are far ahead; few, if any, of the English firms will profit through the exhibition by an increase in their trade; German trade must grow as a result of a show which has been visited by thousands of men of science. The 700,000*l.* of 1898 will rapidly increase.

And why should this be so? Is it our insular ignorance and our unreadiness? In everything, this great exhibition shows the advance of our continental rivals. It is probably true that, in the special circumstances of the exhibition, many prominent firms declined to exhibit. The results will prove conclusively that they made a mistake. Why should I exhibit? said one manufacturer; last time I sent the best of my goods and won a prize, and the French immediately put on heavy duties against them. It is an argument that may have some weight, but does not apply forcibly to scientific apparatus; besides, the French are not the only customers. No; the reason lies deeper. British pluck and doggedness, the individual skill of the British workman, which, on the average, is far above that of his foreign *confrère*, the traditions of British ascendancy in the past, can all do much, but we have not realised—shall we realise them in time?—the efforts our continental rivals are making to rob us of that ascendancy. It is true, as a recent writer in the *Westminster Gazette* puts it, speaking of trade with South Africa, that

"We must be prepared to face the truth that, unless the British manufacturer bestir himself for the supply of this great African community, a great deal of business which, in the natural course of events, should go to him will certainly have to be diverted to Germany and America."

The first step towards curing the disease is to recognise its presence; and how slow we are to do that.

The German catalogue and the exhibit are striking evidences of the services rendered to German trade by the Reichsanstalt.

"The greatest share of the impetus given to the manufacture of scientific instruments," says the catalogue, "is due to the Imperial Physical and Technical Institute. . . . This institution has already done great service, and a large proportion of recent progress is due to its stimulating and helpful influence."

An inspection of the exhibit fully bears this out. We in England have for some time past hoped that the National Physical Laboratory would do for English science all the Reichsanstalt has done for Germany.

It is now two years since the Treasury accepted generally the conclusions of the report of Lord Rayleigh's Committee on the establishment of such a laboratory, and one year since the first meeting of the General Board, and for months the whole scheme has been at a standstill because certain of our rulers attach more weight to the protests of some who object to the selected site than to the deliberate opinion of those whom they have invited to organise and control the laboratory.

It is admitted that the establishment of the laboratory is of national importance. Various difficulties are allowed to delay its erection; meanwhile the Germans go ahead.

Up to the middle of the century our methods were sufficient; that condition of things has ceased. The organised application of science and scientific methods to trade and commerce, indeed to all the affairs of life, is absolutely essential if we are to continue to prosper. Will England realise this truth before it is too late?

NOTES.

THE evening discourses at the meeting of the British Association at Glasgow next year will be given by Mr. Francis Darwin, F.R.S., and Prof. W. Ramsay, F.R.S. The lecture to working men will be delivered by Mr. H. J. Mackinder.

HUXLEY'S life and work is an inspiring subject for a lecturer, and Lord Avebury had no difficulty in interesting the audience which assembled at the Museum of Practical Geology on Tuesday to hear him discourse upon it. The address was the first of the annual lectures established by the Anthropological Institute in memory of Huxley; and as Lord Avebury was a close and intimate friend of the master, he very appropriately inaugurated the series. Readers of NATURE are familiar with a large part of Huxley's work, but a few points mentioned by Lord Avebury will bear repetition. Huxley's Friday evening lectures at the Royal Institution rivalled those of Tyndall in interest and brilliancy; yet he said himself that at first he had almost every fault a speaker could have. He was one of the foremost of those who brought people to realise that science is of vital importance in their lives, that it is more fascinating than a fairy tale and more thrilling than a novel, and that any one who neglects to follow the triumphant march of discovery, so inspiring in its moral influence and its revelations of the beauties and wonders of the world, is deliberately rejecting one of the greatest interests and comforts of life. Apart from his professional and administrative duties, Huxley's works fall into three principal divisions—science, education and metaphysics. Of his contributions to science the Royal Society's catalogue enumerates more than one hundred, and every one of them, in the words of Prof. Parker, "contained some brilliant generalisation, some new and fruitful way of looking at the facts." The value of his

services to education cannot be over-estimated. He maintained that no boy or girl should leave school without possessing a grasp of the general character of science, and without having been disciplined more or less in the methods of all sciences. As regards higher education, he was a strong advocate for science and modern languages, though without wishing to drop classics. There were two things which he said he really cared about—one was the advance of natural knowledge, and the other the bettering of the condition of the masses of the people. How well he furthered both scientific and national progress is known to all of us.

PROF. A. CALMETTE, director of the Pasteur Institute at Lille, who is giving the Harben lectures this year, at the Examination Hall of the Royal College of Physicians and Surgeons, has taken the plague as his subject. In his first lecture, delivered on November 7, he pointed out that plague now menaces all the maritime nations of the globe, and it has become necessary to take rigorous measures to stop its extension. The progress of hygiene and the knowledge acquired during the last five years on the etiology, treatment and prophylaxis of the affection enables it to be combated very efficaciously and its centres to be rapidly circumscribed. It is known that the plague bacillus is found in the buboes and sputa of the patient, that it is also frequently found in the blood, that it has the form of a short bacterium, slightly ovoid, that it is easy to stain by the ordinary laboratory methods, and that it can be cultivated on the usual media. Mice, rats and guinea-pigs show the greatest susceptibility to plague. It has long been remarked that in localities where the plague appears mice and rats die in great numbers, and from the most ancient times, and even to-day, the Chinese and nomadic peoples inhabiting the northern slopes of the Himalayas, so soon as they notice an abundance of dead rats, remove elsewhere to avoid the epidemic they know must be at hand. Of other animals the pig and ox are said to be subject to the plague, but observations show that they cannot take the disease, at least spontaneously. Nor can birds easily contract it; the vultures that devour the corpses of the plague-stricken in the Towers of Silence in the suburbs of Bombay suffer no ill after their funereal repast, though they may distribute plague microbes through their excreta. A monkey was found to contract the plague spontaneously when placed in a cage side by side with another monkey; in this and similar cases the infection was apparently carried by flies or by fleas and other parasites of the skin.

IN connection with the International Exposition at Paris, a number of balloons recently ascended from Vincennes with the object of testing which could remain in the air for the longest period. *La Nature* gives the following results:—Count Henri de la Vaulx descended, after a journey lasting 35h. 45m., at Korostichew, in Russia, the distance from the starting-point being 1925 kilometres, and the greatest altitude 5700 metres. M. Jacques Balsan descended after a voyage of 27h. 5m., having attained a maximum altitude of 6540 metres, and reached a distance of 1345 kilometres from the starting-point. M. Jacques Faure descended in Germany, 950 kilometres from the starting-point, after a journey of 19h. 24m. Upon these results, and those of previous contests, the grand prize in aeronautics has been awarded to Count Henri de la Vaulx.

M. DE FONVIELLE informs us that Dr. Janssen has asked the Aero-Club at Paris to organise a series of three balloon ascents on the nights of Tuesday, Wednesday and Thursday of this week, in order to see whether the Leonids make an appearance or not.

A PAN-AMERICAN EXPOSITION will be held at Buffalo, New York, from the beginning of May to the end of October next year. There will be a large building for electrical exhibits, and in it will be the service plant, for the transformation and distribution of the 5000 horse-power transmitted from Niagara Falls, for lighting and power purposes; a collective exhibit of historical interest, containing illustrative models and apparatus showing important advances in the art; and the commercial exhibit, showing articles possessing distinctive merit, whether consisting of workmanship, novelty or usefulness.

THE opening meeting of the new session of the Society of Arts, the 147th since the foundation of the society in 1754, will be held on Wednesday evening, November 21, when an address will be delivered by Sir John Evans, K.C.B., F.R.S., vice-president and chairman of the Council. For the meetings previous to Christmas the following arrangements have been made:—November 28, Major Ronald Ross, "Malaria and Mosquitoes;" December 5, Prof. H. S. Hele-Shaw, F.R.S., "Road Traction;" December 12, Prof. Frank Clowes, "The Treatment of London Sewage."

AT a recent meeting of the committee of the Liverpool School of Tropical Medicine it was unanimously resolved to invite Dr. R. Fielding Ould, Dr. Balfour Stewart and Dr. A. S. Grünbaum to become assistant lecturers. These gentlemen have already assisted the work of the school in many different ways. On the motion of Mr. Alfred L. Jones it was resolved that the best thanks of the school are due to Drs. Annett, Dutton, and Elliot for their very valuable services in West Africa whilst members of the second malarial expedition of the school. These gentlemen have just returned, bringing with them a quantity of valuable material for future work.

RENEWED interest in the mosquito theory of the propagation of yellow fever, propounded by Dr. C. I. Finlay, of Havana, is aroused by a paper read at the recent meeting of the American Public Health Association at Indianapolis, by Surgeon Walter Reed and Assistant-Surgeons J. Carroll, A. Agramonte and J. W. Lazear. From experiments and observations made in Cuba, in the course of which Dr. Lazear died from yellow fever apparently conveyed to him by an infected mosquito, the following conclusion is arrived at:—"The mosquito serves as the intermediate host for the parasite of yellow fever, and it is highly probable that the disease is only propagated through the bite of this insect."

THE *Times* states that the whaler *Eclipse*, which arrived at Dundee on November 7 from Davis Strait, landed Dr. Leopold Kann, who has for eighteen months been connected with a scientific expedition to the Arctic regions. The expedition, which consisted of Dr. Kann, Mr. Robert Stein, of Washington, U.S.A., and a Boston taxidermist named Mr. S. Warmbath, left Sydney, Nova Scotia, in July 1899, on board the Peary relief ship *Diana*. The Peary expedition was seen in the beginning of August 1899, in three divisions. At that time Lieutenant Peary had been badly frostbitten, having lost several toes, and being only ably to walk with difficulty. The party, which had a large number of sledges and Eskimo dogs, was determined to make a dash for the North Pole.

ARRANGEMENTS have been made for the issue, by the Cambridge University Press, of a journal devoted to the publication of the best original work on hygiene. The periodical will be entitled *The Journal of Hygiene*, and will be issued quarterly. It will be edited by Dr. G. H. F. Nuttall, in conjunction with Dr. John Haldane, F.R.S., and Dr. Arthur Newsholme. The scope of the new journal will be similar to that of the *Archiv für Hygiene* and *Zeitschrift für Hygiene*, and the aim will be to become the chief medium for original workers in hygiene among English-speaking people. The first number of the journal will appear on January 1, 1901.

IN several parts of Germany considerable attention is being paid to electrical appliances that can be used on the farm. Mr. Hughes, U.S. Consul at Coburg, reports that near Ochsenfurt, in Bavaria, a company, composed of land-owners and small farmers, has been organised for the establishment of an electrical system for use on their farms and in villages. The power is to be generated by steam and water, and the current to be distributed from a central station to the places at which it is wanted. Sub-stations are to be established at given points, with the necessary apparatus for connecting with the farm or other machinery, and also for lighting purposes in the houses, offices, roads, and village streets.

FROM the U.S. *Experiment Station Record* (vol. xii., No. 1), we learn that an interesting step, looking to the advancement of agriculture in the Russian Empire, has recently been taken, on the recommendation of the Ministry of Agriculture and Imperial Estates, in the inauguration of a system of commissioners of agriculture to preside over the agricultural affairs in their respective provinces or governments, and to seek to prom ote and improve the agricultural conditions in general. Provision has been made for such commissioners in twenty differe nt governments of the Empire, and the funds for their maintenance became available with the beginning of the present year. These commissioners will have charge of all public measures relating to agriculture and rural affairs, and will exercise supervision over all local agricultural institutions maintained by the government. They will inquire into the agricultural needs of their respective governments, and will r ecommend government aid for such local or private enterprises as merit special encouragement. Connected with the commissioners' offices will be corps of agricultural specialists and instructors, who will be assigned to the work by the Ministry of Agriculture and Imperial Estates. They will go out among the landowners and peasants for the purpose of collecting data regarding the actual conditions of various branches of agriculture, to diffuse general information on agricultural topics, and endeavour to improve the methods and practices in vogue. The inauguration of this system would seem to be a distinct mark of progress. Taken in connection with the recent decrees regarding the establishment of addition al agricultural experiment stations and systems of agricultural education, already referred to, it should materially improve and modernise the practice of agriculture in Russia.

A SIMPLE method of recording the speed of motor cars and other vehicles has been devised by M. L. Gaumont, and accounts of the device appear in *Cosmos* and *La Nature* of November 3. The instrument consists simply of a camera with a double shutter, by which two exposures are made of the same plate, separated by a known interval of time. On developing the photograph two images are obtained of the moving object, and, by measuring the distance between them, the dimensions of the car being supposed known and also measured on the plate, it is easy to calculate the speed of the car at the instant when the photograph was taken. The object is to assist the authorities in regulating the speed of these vehicles and checking furious driving.

THE Cancer Society has just issued its annnal report, from which we learn that one of the great aims of the Society has been to direct public attention to the insidious danger threatening in the increase of cancer. During the past year the Committee have sent out Dr. Arthur C. Duffey to the United States to report on the equipment of the newly-erected Cancer Laboratory at Buffalo, and on his return a detailed report was issued to all the medical schools and to the Press. A prize of fifteen guineas, offered by Miss Scott for the best original essay on the present state of cancer science, has been awarded to Dr. Alexander Fraser, of Manchester. An elementary pamphlet by Dr. Herbert Snow, laying down maxims for the avoidance and early recognition of cancer, has been issued, together with numerous other publications bearing on the subject.

DR. QUIRINO MAJORANA contributes to the *Atti dei Lincei* an account of experiments dealing with the behaviour of carbon at high temperatures and pressures. In M. Moissan's experiments on the transformation of diamonds, the partial crystallisation of the carbon was attributed to (1) the high temperature of the central mass, (2) the solubility of the carbon in the metallic mass, and (3) the pressure. Dr. Majorana, finding that in his previous experiments the crystals obtained were much smaller than those produced by Moissan, has conducted a fresh series of experiments in which he has maintained the carbon at a pressure exceeding, and a temperature equalling, that employed by Moissan, for a considerably longer period of time, without producing so marked an increase of density. From this he considers it probable that the solubility of the carbon in the surrounding medium is one of the principal factors in the crystallisation.

A SERIES of papers dealing with the properties of pozzolana, and its use in mortars and cements exposed to the action of sea-water, is contributed to the *Gazzetta chimica italiana* by M. O. Rebuffat. In one of these papers the author discusses the reactions of the several silicates of alumina entering into the composition of pozzolana, with especial reference to the production of artificial cements of this character. In con nection with the action of sea-water, the principal results are that sea-water transforms the cement of mortars containing pozzolana into a hydrated silicate of alumina containing small quantities of lime and magnesia and quantities not negligible of alkalis. The silicate, by its composition, is altogether unaffected by the salts of sea-water. Seeing that in mortars immersed in sea-water the lime, after binding the mortar together, ultimately disappears completely, the use of mixtures of cement and pozzolana is not recommended. The author advocates the old plan of screening the pozzolana, and deprecates the use of finely ground pozzolana mixed with sand.

PROF. R. SISSINGH, of Amsterdam, has published a short treatise on the general properties of images formed by direct pencils traversing a system of spherical surfaces. This treatise contains a simplification of the proofs applicable to an optic system formed of lenses centred on the same axis. The theory now offered is essentially physical in character; at the same time, the ordinary geometrical properties of images are also established, and the optical properties of the eye are considered. Prof. Sissingh takes no account of aberration other than chromatic aberration. The monograph is reprinted from the *Verhandelingen* of the Royal Academy of Amsterdam, and published by Johannes Müller, of Amsterdam.

WE have received from Sir Charles Todd, Government Astronomer of South Australia, a report upon the Rainfall of the Colony during 1897, showing the monthly and yearly values at 415 stations, together with the number of days on which rain fell, the greatest fall in one day, and the mean of the rainfall for a number of previous years. The rains during the year were irregular and, on the whole, below the average over the whole colony; in October a dry spell set in, which lasted during the rest of the year, and practically ruined the agricultural prospects. As an instance of the lengthy drought to which places in the interior are subject, Charlotte Waters in 1896 had 2·84 inches only, and 1·16 inches in 1897. A valuable table is given, showing the yearly rainfall at Adelaide for 59 years from 1839 to 1897, and the years when the amount was above or below the general average (20·886 inches) for the whole period.

WE learn from the U.S. *Monthly Weather Review* that the Russian Meteorological Office has published a comprehensive meteorological atlas, to commemorate the fiftieth anniversary of the foundation of the Central Physical Observatory by the Emperor Nicholas I. on April 1, 1849. It contains eighty-nine charts and fifteen graphical tables, and exhibits the prominent features of the climate of the Russian Empire from Warsaw on the extreme west, to Bering Strait on the east, and from Teheran on the south, to the Arctic Ocean. This range of 40° of latitude and 160° of longitude represents one of the most extensive meteorological systems in the world. The mean values of all the principal elements are exhibited in monthly and annual charts, the rainfall being shown for seasons. One of the charts shows the number of days during which snow lies on the ground; the region of the maximum number of days (190) extends from Archangel east-south-eastward beyond the Ural. From this region the number of days diminishes until we reach sixty days on the northern shores of the Caspian Sea, and twenty days on the north-western shores of the Black Sea. The paths of cyclones and types of weather in Russia, in so far as the latter depend on barometric conditions, are shown by five charts. The whole work is pronounced by the U.S. Weather Bureau to be a magnificent production, and illustrative of the activity of this vast meteorological service.

THE *American Museum Journal*, of which we have received the third part, appears to be a publication well worth the attention of museum authorities in other countries. It is issued monthly, and is stated to be a popular record of the progress of the American Museum of Natural History; the present part, which is well illustrated, containing fifteen pages of text. The first article is an obituary notice of the late Mr. J. M. Constable, the Vice-President of the museum. This is followed by a record of recent donations to the library, and this again by a reference to an exhibit displaying the fauna of New York, which has been recently added to the museum and appears to have attracted much attention from the public. Other articles describe the development of the museum, the work and progress of the Department of Public Instruction, and the work which has been recently accomplished in the anthropology of the Pueblo and Cave-dwelling Indians of New Mexico and the adjacent territories.

THE feature of the *Entomologist* for November is the continuation by Dr. Max Standfuss of the account of his experiments in hybridisation among the Lepidoptera, and the effects of temperature on those insects; the paper being illustrated by a plate of abnormally coloured butterflies. As regards these abnormalities (several of which occur occasionally in nature) produced by temperature variation, the author considers that they are not atavistic. A large proportion of them are infertile, and the majority of those which bred produced normal offspring, only the most abnormal female transmitting more or less of its newly acquired characters to its progeny. Although the experiments, on account of disease, were incomplete, their result, so far, seems to demonstrate that the possibility of perpetuating the abnormalities depends on the degree to which these depart from the ordinary form.

THE *Transactions* of the New Zealand Institute for 1899 contains thirteen papers on zoology, seven on botany, and five on geology, the great majority relating to the colony itself. Of especial interest is the record, by Prof. Benham, of the occurrence of a species of Balanoglossus in New Zealand waters, while a note on the freshwater crayfishes of the colony, by Dr. C. Chilton, will attract the attention of students of the crustacea. The practical extermination of the great purple coot (*Notornis mantelli*) is attributed by Mr. R. Henry very largely to rats, which, by eating the wild grain and seeds, prevent the bird from obtaining its proper nutriment. It will be news to many ornithologists that, about twenty years ago, the ship *Gleaner* came into Greymouth with a strange bird on board which turned out to be either the New Zealand or the Australian giant coot, and had reached the vessel at a distance of 400 miles from the shore. These birds were supposed to be practically incapable of flight.

WE have received from the U. S. Department of Agriculture, No. 19 of the "North American Fauna," which describes the results of a biological reconnaissance of the Yukon river region. The memoir is divided into three sections, of which the first is devoted to a general account of the region, while the second and third respectively treat of the mammals and the birds. For the latter Dr. L. B. Bishop is responsible, the two former sections being the work of Mr. W. H. Osgood. Although the whole area belongs to what American writers term the boreal zone, it has been found possible to divide it into several formal districts, the *tundra* being assigned to the Arctic province, while the Yukon Valley itself comes mainly within the Hudsonian division, but also contains a distinct Canadian element. In addition to several which have been described a short time previously, the memoir notices three birds and nine mammals which are regarded as new. It seems, however, pushing refinements of distinction a little too far to regard the two forms of reindeer met with in Alaska, as well as the elk, as distinct species.

PART ii. of vol. lxviii. of the *Zeitschrift für wissenschaftliche Zoologie*, which has just reached us, contains two papers; one, by Herr Samter, an elaborate dissertation on the development of the crustacean *Leptodora hyalina*, the other, by Herr S. Metalnikoff, an account of the anatomy and histology of the worm *Sipunculus nudus*. Both communications are exquisitely illustrated.

To the August number of the *Journal* of the Bombay Medical and Physical Society, Dr. N. F. Surveyor contributes an illustrated account of the parasitic invasions to which the eggs of the cockroach are subject. These include two Hymenoptera, several kinds of moulds, probably several beetles, possibly another cockroach-like insect, and the parent itself. The importance of the subject will be apparent when it is stated that several of the parasites of the cockroach may pass a portion of their existence within the body of man himself.

IT has been shown by Dr. C. L. Griesbach, the Director of the Geological Survey of India, that the Trias of the Himalaya contains several well-marked horizons of Cephalopods not only in the Muschelkalk, but above and below it. The rich series of specimens collected in recent years has been submitted to Dr. Edmund Mojsisovics of Vienna, and he has written an elaborate memoir on the Upper Triassic species ("Palæontologia Indica," Ser. xv. Himalayan Fossils, vol. iii., part I., 1899). This memoir has been translated into English for the Indian Survey by Dr. and Mrs. A. Foord. The main portion of the work is naturally devoted to a description of the species, which are ranged under genera, whose characteristics can be understood only by those palæontologists who devote particular attention to the subject. Among the genera familiar when General Strachey first discovered Triassic fossils in the Himalaya, *Ceratites*, *Nautilus* and *Orthoceras* alone appear, but a host of others, needful to express the results of modern discrimination, find place in the volume. Of most interest to geologists are the general results arrived at by Dr. Mojsisovics. He refers to the local character of the Indian Upper Triassic fauna, but observes that there can be no doubt of the former existence of an open connection of the sea between the Indian and Mediterranean provinces. The Indian Trias province forms an integral part of

the "Thetys," or great Trias sea, named by Ed. Suess, which extended from the Mediterranean eastwards through Central Asia, and included the Germanic shallow sea. Some remarks are also made on the Arctic-Pacific Trias Province.

THE geology of Bad Nauheim and its thermal salt-springs form the subject of an interesting article by Mr. A. Vaughan Jennings (*Geological Magazine*). He notes the fact that, sixteen centuries ago, Bad Nauheim was a Roman sanatorium, its fame arising from the small natural springs of thermal water. During the present century several borings have been made to largely increase the supply of water; the last one, made in 1855, was carried to a depth of 180 metres. The water appears to be pent up in a basin of Devonian rocks covered by Tertiary strata. The author discusses the source of the water, its temperature and saline ingredients.

THE Essex Field Club has issued, as No. 4 of its museum hand-books (price 2*d.*), a sketch of the crag formation of East Anglia, by Mr. W. H. Dalton.

WE have received Nos. 21 and 22 of *Spelunca*, or *Bulletin de la Société de Spéléologie*, which contains a variety of information about caves and water-channels, with notices of recent publications.

THE growth and retreat of Norwegian glaciers is dealt with by Mr. J. Rekstad (*Norges Geol. Undersogelse*, No. 4). He draws attention to the evidence of great fluctuations in the amount of ice extending over periods of at least two hundred years, and remarks that these periods of general increase or decrease are accompanied by minor oscillations in the glaciers.

MR. R. BULLEN NEWTON has described some marine mollusca from the Upper Trias in the Malay Peninsula. These include the well-known and widely distributed *Chlamys* (*Pecten*) *valoniensis*, as well as species of *Pleurophorus*, *Myophoria*, &c., which indicate the horizon of the Rhætic beds (*Proceedings*, Malacological Soc., Oct. 1900).

THE newly-appointed Government Geologist of Queensland, Mr. W. H. Rands, has forwarded a copy of the annual progress report of the Geological Survey for 1899. He takes occasion to express the general feeling of regret at the resignation of his predecessor, Mr. R. L. Jack. The report, which deals mainly with copper, gold, and coal properties, includes contributions by Mr. B. Dunstan on the occurrence of oriental ruby in northern Queensland, and on fire-clay.

CANON SCOBELL contributes to the *Proceedings* of the Cotteswold Club (vol. xiii. part iii.) some interesting notes on the common fields at Upton St. Leonard's, and these are accompanied by a view of lynches, which indicate the ancient system of ploughing in strips and terraces. In some excursion notes Mr. S. S. Buckman deals with river features in the phraseology used by Prof. W. M. Davis. He refers also to the tunnel near Chipping Sodbury on the South Wales direct railway, to the water therein encountered, and to the probable effects consequent on its diversion by pumping.

To the *Bulletin* of the American Geographical Society, vol. xxxii., 1900, Mr. R. L. Barrett contributes an interesting account of the Sundal drainage system in central Norway. The author explains the curious "reversal of drainage" which has occurred in this region, and deals with the question of the "hanging valleys" and erosion by overflowing glaciers.

IN a paper brought before the Academy of Sciences of Cracow, Mr. L. Marchlewski has described a new derivative of chlorophyll. This substance, which its discoverer has named phyllorubine, differs considerably from the previously known phylloporphyrine, another chlorophyll derivative. While the spectrum of the latter is distinguished from that of other chlorophyll derivatives by having no band in the red region, phyllorubine forms no such exception. The new substance has not yet been obtained in the crystalline state.

THE action of chemical solutions on the lower forms of life is the subject of two papers in German in the *Journal* of the College of Science, Imperial University of Tokio—one, by N. Ōno, dealing with their effect on the growth of algæ and fungi, while the other, by Prof. Atsushi Yasuda, treats of the adaptability of infusoria to concentrated solutions. The former author finds that certain poisons in a highly diluted state favour the growth of the lower algæ, that smaller "doses" are required with algæ than with fungi, that mercury chloride and copper sulphate in certain degrees of dilution favour the growth of fungi (a remarkable result, seeing that corrosive sublimate in stronger concentration is used as a preventive of mildew), and that spore-formation is retarded by certain chemicals. Prof. Yasuda, on the other hand, finds that infusoria are affected by a much lower degree of concentration than algæ and fungi, even the most resistive species, *Euglena viridis*, being unable to exist on any but relatively weak solutions. An account is given of the physiological changes which take place in the organisms as the degree of concentration is varied.

A PRELIMINARY note on the fungi collected in the Belgian Antarctic Expedition is contributed to the *Bulletin de la Classe des Sciences* of the Belgian Academy by Mesdames Bommer and Rousseau. Almost all of these come from Tierra del Fuego. One species alone was found in Dango Land, *i.e.* the Antarctic region proper; but this species has not been classified, as it is represented only by a sclerotium, without carpophore. Among the fungi of Tierra del Fuego, out of fifteen species collected ten were new.

DR. GEORGE NEWMAN'S book on "Bacteria," published a year ago in Mr. John Murray's Progressive Science Series, and reviewed in these columns (vol. lx. p. 434, September 7, 1899), has met with the success which its excellence deserves. A new edition has been issued, with additional matter, including new chapters on tropical diseases and on the bacterial treatment of sewage.

THE second volume of the new edition of the well-known "Gardener's Assistant," which has been revised and entirely remodelled under the direction and general editorship of Mr. William Watson, of the Royal Gardens, Kew, has just been issued by the Gresham Publishing Company. The work, so far as it has gone, is thoroughly in touch with the spirit of modern gardening, and should be in the hands of every practical horticulturist.

MESSRS. WILLIAMS AND NORGATE'S *Book Circular* is known to many men of science as a useful guide to foreign scientific works, containing not only the titles and other publisher's particulars, but also notes describing the scope and character of the contents. Eight of these circulars, referring to works published during last year and this, have now been issued in volume form, and the book thus produced is a handy catalogue of important scientific publications which have lately appeared.

ANOTHER part of Engler's "Monographieen Afrikanischer Pflanzen-familien und-Gattungen" has been received; and in it Dr. K. Schumann deals with the African Sterculiaceæ. The work is being prepared, regardless of expense, under the auspices of the Berlin Academy of Sciences, and is published by W. Englemann, Leipzig. The trustees of the British Museum (Natural History) have just published a new part of the "Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853-61." This is the fourth (and concluding) part of Mr.

W. P. Hiern's description of the dicotyledonous plants collected by Dr. Welwitsch, the first having been published at the end of 1896.

THE *Bibliotheca Geographica*, edited by Dr. Otto Baschin for the Berlin Geographical Society, is known to be a most complete annual and international bibliography of geographical literature. The sixth volume of this catalogue contains the titles of papers published during 1897, classified into the usual groups according to subjects, and with an authors' index. It is thus possible to find, without the slightest difficulty, what papers upon any particular district or branch of geography were published in 1897, or to look up the list of publications of any writer on geographical subjects. The volume contains 444 pages, and it does credit to the editor and the society under whose auspices it has been prepared.

THE additions to the Zoological Society's Gardens during the past week include a Lioness (*Felis leo*) from East Africa, presented by Major T. Soutar, Cameron Highlanders; a Sooty Mangabey (*Cercocebus fuliginosus*, ♂) from West Africa, presented by Major G. McMicking, commanding C.I.V. Field Battery; two Ostriches (*Struthio camelus*), a Nilotic Crocodile (*Crocodilus niloticus*) from East Africa, presented by Mr. G. Marsden; an Egyptian Jerboa (*Dipus oegyptius*) from North Africa, presented by Mrs. R. Gurney; a Barn Owl (*Strix flammea*), British, presented by Lady Hutt; a Leopardine Snake (*Coluber leopardinus*), a Tesselated Snake (*Tropidonotus tessellatus*), European, presented by Mr. W. J. Wintle; a Grey-cheeked Mangabey (*Cercocebus albigena*, ♂), a Sooty Mangabey (*Cercocebus fuliginosus*, ♀) from West Africa, a Moustache Tamarin (*Midas mystax*) from the Upper Amazons, a Yellowish Capuchin (*Cebus flavescens*) from South America, two Tenrecs (*Centetes ecaudatus*), a Short-nosed Tenrec (*Ericulus setosus*), a Long-nosed Tenrec (*Hemicentetes semispinosus*) from Madagascar, a Festive Amazon (*Chrysotis festiva*) from Guiana, two Tui Parrakeets (*Brotogerys tui*), a Hawk-headed Parrot (*Deroptyus accipitrinus*) from Brazil, deposited; two Grey Squirrels (*Sciurus griseus*, var.) from North America, purchased; a Bosch-bok (*Tragelaphus sylvaticus*, ♂), eight Mocassin Snakes (*Tropidonotus fasciatus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF THE INFRA-RED SPECTRUM OF THE SOLAR CORONA.—In a recent issue of the *Comptes rendus* (vol. cxxxi. pp. 658-661), M. Deslandres describes some of his latest experiments in connection with the detection of the solar corona at ordinary times without the intervention of an eclipse. All the methods adopted prior to 1894 had been modifications of spectroscopic examination, using either the visual or ultra-violet rays, and were probably unsuccessful owing to the great proportion of these radiations existing in our general sky illumination, thereby diluting the small direct coronal light. In 1894 M. Deslandres found evidence that the sky radiation was very poor in the infra-red region, while the corona emitted this light abundantly, and this has since been investigated by Prof. Hale, in 1895, without producing any confirmatory results. M. Deslandres here suggests, however, that this non-success may have been due to those experiments having been made near the period of maximum sun-spot activity, at which time the corona is much more uniformly distributed round the limb than at periods of minimum.

During the last eclipse, in May 1900, the author, in conjunction with M. Charbonneaux, found that the infra-red coronal radiation was some one-half or one-third the radiation of the same part of the sky after the eclipse, and the work has since been continued daily at the Observatory of Meudon with the same apparatus. This consists of a mirror 0·30 metre aperture and 1·50 metres focus, a slit spectroscope with crown lenses and prisms, a sensitive Melloni or Rubens thermopile, and a very sensitive Deprez-d'Arsonval galvanometer. The slit of the spectroscope was 12 mm. long and 1 mm. wide, the prism train being so arranged that the thermopile only received the infra-red radiation from $\lambda 1\mu$ to $\lambda 1\mu{\cdot}8$. The slit has also been replaced by circular apertures 0 4 mm. and 1 mm. diameter.

The interesting conclusion is that, at all times of the day, the sum of the deviations along the equatorial region has always been greater than the corresponding sum of the readings in a polar direction. As it is improbable that the diffuse heat of our atmosphere would be unequally distributed over the small area corresponding to the angular diameter of the sun, this difference can only be attributed to the effect of the corona; the present time being a minumum of spots, the greater action along the equatorial region is in agreement with the known conspicuous equatorial extensions of the coronal streamers and the comparatively small polar plumes. Many variations in the disposition of the apparatus have been made to discover any possible systematic errors, but the results have throughout remained the same.

In contrast with the above report should be considered the preliminary statement of the results obtained by the expedition organised by Prof. S. P. Langley from the Smithsonian Institution during the same eclipse (*Astrophysical Journal*, vol. xii. pp. 69-76). The light given from a 17 inch siderostat mirror passed to a concave speculum 50 cm. diameter and 1 metre focus. Arrangements were made whereby either the full image of a part of the solar surroundings could be allowed to fall on the bolometer strip, or the light previously passed through a prism, thus sifting out any particular radiation for action on the bolometer.

Settings on the inner corona gave a distinct *negative* deflection with respect to the zero of the instrument, but this was numerically less than the deflection given by a setting on the centre of the dark moon; this shows that the coronal radiations were recognised by the bolometer, giving some 5 mm. deflection greater than that of the dark moon.

The fact of the negative deflection, however, indicates that the radiation reflected by the earth's atmosphere during the partial phase is vastly more intense than that of the corona. Also "the corona is effectively cooler than the bolometer, and appears, therefore, neither to reflect much light from the sun, nor, chiefly by virtue of a high temperature, to give light of its own, but seems rather to be giving light in a manner *not associated with a high temperature*, or at least with the preponderance of infra-red rays usual in the spectra of hot bodies."

ANNUAL REPORT OF THE MELBOURNE OBSERVATORY.—In the thirty-fourth annual report of the Melbourne Observatory, Mr. P. Baracchi, the acting Government astronomer of Victoria, summarises the work accomplished at the institution during the period March 1, 1899, to March 31, 1900. With the 8-inch transit circle the total number of right ascension observations was 3311, and of north polar distance 2406. Of the latter, 1435 were on stars selected from the astrophotographic catalogue plates, to serve as fundamental stars for the reduction of these plates. 786 observations of heliometer stars were made at the request of Dr. Gill, and have been sent to him for comparison. The computations for the third Melbourne General Catalogue of 3100 stars are about two-thirds completed. The astrographic work has made considerable progress, the two series of catalogue plates and the series of chart plates with single exposure of one hour having been completed with the exception of a few scattered regions. Catalogue plates for regions above 80° of declination are being duplicated, and the second series of chart plates, with triple exposure of 30 minutes each, has been commenced, giving three images of each star about 8″ apart. The measurements of the catalogue plates taken at this observatory and the Sydney Observatory have been made at Melbourne, and the progress made is stated in a joint report by Messrs. H. C. Russell and P. Baracchi. The first twelve months of the existence of the measuring bureau (commencing November, 1898) were occupied in preliminary instrumental experiments and training of observers, but during the last four months systematic measurement has been carried on Several new micrometers have been obtained, one by Repsold, similar to that used by Dr. Gill at the Cape. This has double slides, and thereby permits quicker measurements. At present two observers, relieving each other for alternate periods of one hour, measure in a day about 500 stars with the Repsold and about 400 with the local micrometer. As the total number of stars on the Sydney and Melbourne plates is probably 1,500,000, it is estimated that with three efficient measuring machines, and six observers employed from six to seven hours daily, the whole may be accomplished in some six or seven years. The photoheliograph, great telescope

and other equatorials have only been used on special occasions and for visitors, 594 of whom inspected the observatory during the year.

The automatic photographic registration of terrestrial magnetism was obtained with only 34 hours interruption during the year; absolute measurements were made on seven occasions, and instrumental constants, &c. determined.

The series of cloud photographs has been continued, 77 additional pairs of plates being taken from the roof of Parliament House and the observatory grounds respectively. These are now being measured and discussed in connection with visual observations.

ABNORMAL STARS IN CLUSTERS.—Prof. E. E. Barnard has for some time been engaged in micrometrical determinations of the positions of a number of the individual stars in the great globular clusters M 3, M 5, M 13, M 15, and M 92, and in the course of the work has noticed several peculiarities, the most striking of which is the fact that some of the stars in these clusters shine with a much *bluer* light than the majority of their neighbours, thus producing a remarkable difference between their photographic and visual magnitudes. So striking is this that the images in some cases are so large as to suggest variability (*Astrophysical Journal*, vol. xii., pp. 176—181). Comparisons have been made with a negative enlarged four times from an original of M 13 Herculis, taken with the Potsdam 13-inch photographic refractor in 1891.

The two stars, Nos. 148 and 131 of Scheiner's catalogue of this cluster are practically equally bright to the eye as seen in the sky; but on the photograph No. 148 has an image four or five times larger than No. 131.

Other neighbouring stars, however, register photographically the same relative brightness as determined visually. This led to the minute examination of No. 148 with high magnifying power, when it gave the impression of some object less sharp than stars near it, suggesting the idea of a small planetary nebula. Other stars showing the same abnormal features are detailed, and a numbered sketch of a portion of the cluster given for identification.

Prof. Barnard says he has found similar cases in other clusters, *e.g.* M 5 Libræ. A suggestion by Prof. Hale that a photograph taken through a yellow screen should not show these peculiarities was tested on the 40-inch Yerkes refractor and proved correct, the stars previously mentioned coming out on the photograph with almost the identical relative brightness they show visually in the same telescope.

The suggestion is made that these stars are of similar nature to the condensation or nucleus of the annular nebula in Lyra, perhaps bearing the same relation to the other stars of the cluster that the nucleus of that nebula does to the ordinary stars of the sky. It would appear, therefore, that the possibility of these abnormal stars being of the nature of nebulæ brings up again the question of nebulosity in the globular clusters.

RECENT STUDIES OF INFRA-RED REGION OF SOLAR SPECTRUM.—In the current issue of the *Comptes rendus* (vol. cxxxi. pp. 734–736), Prof. S. P. Langley describes the result of his recent work on the bolometric study of the solar spectrum in the infra-red. At the date of his last communication to the French Academy, in 1894, the knowledge of the region beyond $\lambda = 1\mu$ was very imperfect, but now, thanks to the great improvement of his bolometer, which is capable of detecting a variation of temperature as minute as the millionth part of a degree, the map of the calorific rays has been carried to $\lambda = 5{\cdot}8\mu$. The article is illustrated by a heliogravure of the calorific spectrum from $\lambda = 0{\cdot}76\mu$ to $\lambda = 5{\cdot}3\mu$, both the galvanometer record and the "line" integration being given. More than 600 lines are recorded, each of which has been studied separately and obtained by from six to twenty independent observations. Prof. Langley calls special attention to the observations of the *telluric* infra-red spectra, which have been studied during all seasons from 1895–1900. Systematic variations have been observed in them which appear to have some relation to the season in which they occur, and, although small, are very distinct.

THE ZODIACAL LIGHT.—*The Observatory* for November contains the first part of an article giving in a concise form the complete history of the zodiacal light. In this number the history is brought up to the year 1855, being derived mainly from two sources; (1) the article by M. E. Lefébure in *Ciel et Terre*, April, 1894; (2) a Review by Prof. C. E. Brame in the *Popular Science Monthly*, October, 1877.

THE NAPLES ZOOLOGICAL STATION.[1]

THE Zoological Station at Naples is so well known, either by personal experience or by repute, to zoologists the world over, that it may seem to some that any further account of it is quite unnecessary. But the institution has lately extended its scope and increased its equipment so as to appeal to workers in other lines of biology; and, moreover, as certain Associations and Universities in this country and elsewhere give annual grants towards defraying the expenses of special researches at Naples, it is due to scientific men in general that they should be kept informed from time to time of the conditions under which such work is carried on.

About ten years ago the then chairman of the British Association Naples Committee visited Naples, and gave an interesting report (NATURE, February 1891, p. 392) on the condition of the Zoological Station, in which he dwelt mainly upon the history, constitution, finance and publications; it will, therefore, be best that I should now draw attention chiefly to the present facilities for work at this world-renowned laboratory, and to the additions and improvements effected during the last decade. I am indebted to Prof. Dr. Anton Dohrn, the director, and to the secretary, Mr. Linden, for much information given me during my recent visit.

Since Dr. Sclater's visit in 1890 additional accommodation has been obtained by a re-arrangement of the roof of the main building. This gives space for a second laboratory, a supplementary library, and various smaller rooms used as chemical and physiological laboratories, for photography and bacteriology. A good deal of the research in recent years, both on the part of those occupying tables and of the permanent staff, has been in the direction of comparative physiology, experimental embryology, and the bacteriology of sea-water, and all necessary facilities for such work are now provided.

The number of work-places, in some cases separate rooms, known technically as "tables," is about fifty-five, and of these about thirty-four are rented annually by States, Universities, or Associations. Germany takes about ten of these, and Italy seven. There are three American tables, and three English (rented by the Universities of Cambridge and Oxford and the British Association respectively); consequently there are generally about half a dozen English and American biologists at work in the station; but Dr. Dohrn interprets in a most liberal spirit the rules as to the occupancy of a table, and, as a matter of fact, during my recent visit there were, for a short time, no less than three of us occupying simultaneously the British Association "table," and provided with separate rooms.

A work-table is really a small laboratory fitted up with all that is necessary for ordinary biological research, and additional apparatus and reagents can be obtained as required. The investigator is supposed to bring his own microscope and dissecting instruments, but is supplied with alcohol, acids, stains, and other chemicals, glass dishes and bottles of various kinds and sizes, drawing materials and mounting reagents. Requisition forms are placed beside the worker on which to notify his wishes in regard to material or reagents, he is visited at frequent intervals by members of the staff, and all wants are supplied in the most perfect manner. The recent addition of carefully planned filter-beds, by means of which half the sea-water in circulation in the tanks can be filtered and separated from the rest, has materially increased the facilities for some classes of experimental work.

The staff of the station consists of:—

(1) Dr. Anton Dohrn, the founder and director.

(2) Seven or eight scientific assistants—viz. Dr. Eisig, administrator of the laboratories; Dr. Paul Mayer, editor of the publications; Dr. Giesbrecht, assistant editor and supervisor of plates; Dr. Gast, assistant editor and supervisor of microscopic drawings; Dr. Schöbel, librarian; Dr. Lo Bianco, administrator of fisheries and préparateur; Dr. Hollandt, temporarily in charge of the microscopic sections department—all of them well-known men, each eminent in his own line of investigation. The post of assistant in the physiological department, formerly held by the late Dr. Schoenlein, is now vacant.

(3) In addition to the foregoing there are:—The secretary, Mr. Linden; two artists and the engineer.

(4) Also about thirty attendants, collectors and others em-

[1] Abridged from the "Note by the Chairman" of the Naples Committee in the report presented to the British Association at Bradford, September 1900.

ployed in the laboratories, in the collecting and preserving departments, aquarium and elsewhere.

This seems at the first thought a very large staff, but the activities of the institution are most varied and far-reaching, and everything that is undertaken is carried to a high standard of perfection. Whether it be in the exposition of living animals to the public in the wonderful tanks of the "Acquario," in the collection and preparation of choice specimens for Museums, in the supply of laboratory material and mounted microscopic objects to Universities, in the facilities afforded for research, or in the educational influence and inspiration which all young workers in the laboratory feel—in each and all of these directions the Naples station has a world-wide renown. And the best proof of this reputation for excellence is seen in the long list of biologists from all civilised countries who year after year obtain material from the station or enrol as workers in the laboratory. Close on 1200 naturalists have now since the opening of the Zoological Station in 1873 occupied work-tables, and as these men have come from and gone back to practically all the important laboratories of Europe and America, from St. Petersburg to Madrid, and from California to Japan, Naples may fairly claim to have been for the last quarter of a century a great international meeting-ground of biologists, and to have exercised a stimulating and co-ordinating influence upon biological research which it would be difficult to over-estimate.

The opportunities for taking part in collecting expeditions at sea are most valuable to the young naturalist. Dredging, plankton-collection and fishing are carried on daily in the Bay of Naples by means of the two little steamers belonging to the station, and a flotilla of fishing and other smaller boats. Many of the Neapolitan fishermen are more or less in the employ of the station, or bring in such specimens as they find in their work. The collecting organisation, under the charge of Dr. Lo Bianco, is now sufficient to provide from fifty to sixty workers at a time with all the material requisite for their varied researches.

But although the work of the Naples Zoological Station is thus many-sided, the leading idea is certainly original research. An investigator goes to Naples to make some particular discovery, and he goes there because he knows he will find material, facilities and environment such as exist nowhere else in the same favourable combination. The British Association Committee consider it most important that these opportunities for research should be open to British biologists in the future as they have been in the past, and it is on this ground that they confidently recommend the policy of sending selected investigators to Naples each year—a practice which has led to such satisfactory results in the past, and is full of promise for the future.

W. A. HERDMAN.

THE BRADFORD MUNICIPAL TECHNICAL COLLEGE.

DURING the recent Bradford meeting of the British Association many members availed themselves of the opportunity of inspecting the splendid Technical College which commenced a new era under the auspices of the Municipal Council twelve months ago. A description of the organisation of the college, and the work of its various departments, is given in the current number of *The Record of Technical and Secondary Education*, from which source, and the *Bradford Observer*, the following particulars have been derived. We are indebted to the Editor of the *Record* and to Mr. J. Nutter, secretary of the school, for the accompanying illustrations.

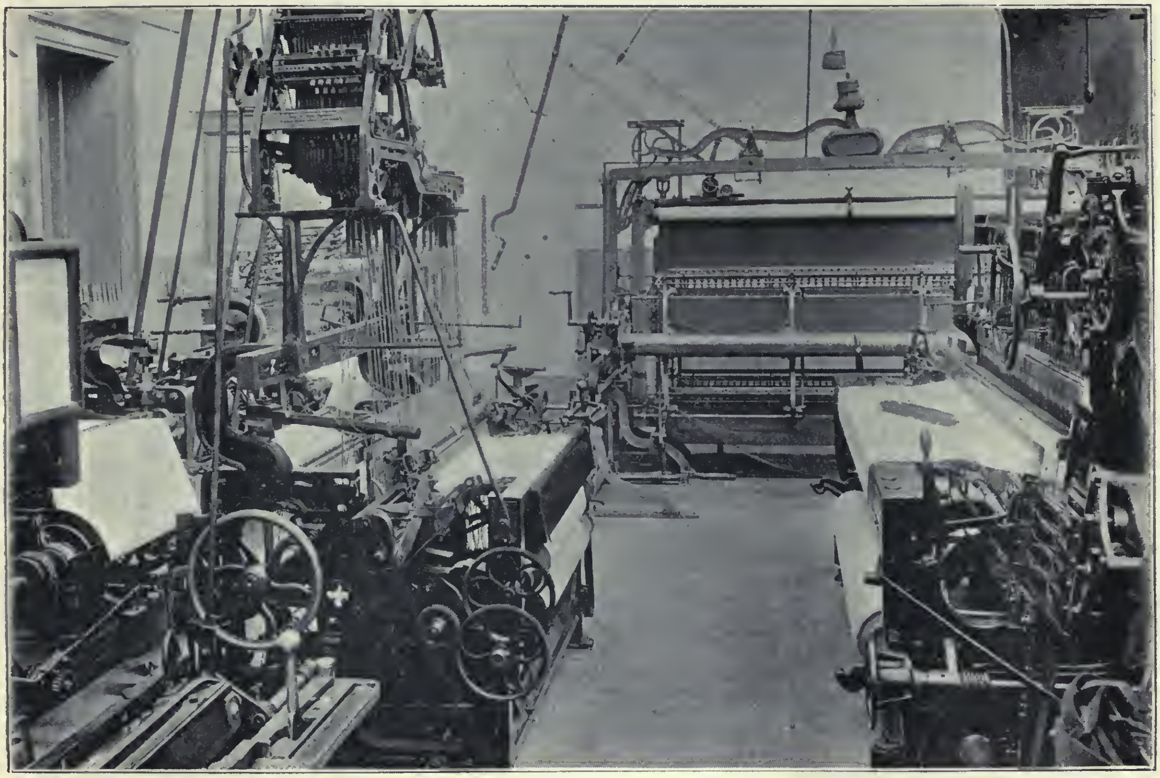


FIG. 1—Department of Textile Industries, Bradford Municipal Technical College—power loom shed, showing dress goods and coating looms and embroidery frame.

The management of the college is now in the hands of the Technical Instruction Committee of the Bradford City Council, and the scheme defining the objects of the college is as follows:—"The general object of the foundation shall be the maintenance of a technical college under the Technical Instruction Acts for persons above 14 years of age, subject to the provision that no secondary day school or school of science shall be carried on in the college, but that day and evening classes may be held in the subjects of art, and of manual, scientific or technical instruction connected with the trades and manufactures of Bradford and the neighbourhood, to which none shall be admitted under the age of 15 years, except on the recommendation of the governing body of

the school in which they have been taught, and in no case under the age of 14 years; in advanced commercial subjects at day and evening classes, to which none shall be admitted under the age of 16 years."

Department of Textile Industries.

In the textile industries department, which is directed by Mr. A. F. Barker, the idea that a satisfactory knowledge of the subject can be gained at evening classes has been given up as fallacious. A three years' course of study for day students has been mapped out, and students who enter must take at least two years of the course, though it is preferable that the whole should be gone through. In addition, a one-year course of textile-mechanics has been arranged, and a special textile and dyeing course is also available for those who desire to carry their studies still further. Such evening classes as have been arranged are all specialised courses for the benefit of those who, having passed through the day classes, are now engaged in the textile trade. In the day classes the teaching of the subject is subservient to the training of the student: in the evening classes means are afforded the already well-grounded student for gaining all possible up-to-date knowledge of his particular branch of the trade. One item in the arrangements deserves special mention, as it is an anticipation of the great development which will eventually take place. Lectures on the preparation of wool and its treatment until it reaches the yarn stage are included in the three years' day course, and for the evenings a course of twenty-five lectures by acknowledged experts in the various branches has been arranged. This is in preparation for the carrying out of the full plan of the committee to remodel the textile industries department by providing plant for the practical teaching of the whole of the operations involved in the production of cloth from the raw material. The Clothworkers' Company have recently carried out a similar scheme at the Yorkshire College. The idea, which as far as possible will be worked to, in providing new buildings and machinery, is to make the college a model factory in which, subject to obvious limitations, work will be carried out on an economical and commercial scale. In the "model factory" each department would balance the other. For instance, there would be a sufficiency of spinning frames to supply the necessary yarn to the looms, and so on throughout. Many important advantages would follow such a scheme. It would add interest to the work, and the students, in addition to gaining skill in the various operations and knowledge of the scientific laws which govern them, would also get an insight into mill management, a practical acquaintance with manufacturers' book-keeping, and a grasp of the economic problems involved.

Department of Chemistry and Dyeing.

Mr. W. M. Gardner is in charge of this department. In addition to the work in the chemical laboratories and experimental dyehouse, it is intended that in the future a practical dyehouse, fitted with typical machinery—including finishing machines—shall be provided, in which the students may be introduced to practical work. An experimental dyehouse for trade research work will also be an important feature in the future. The complete course in chemistry and dyeing occupies three years. The first year's work consists largely of chemistry and physics; the second includes chemistry, but dyeing is specially studied; and in the third year the work is to be still more specialised, and the students will be engaged during a part of their time in the dyeworks of the city. The course is made as complete as possible by the inclusion of physics (with special reference to chemical questions and to colour) and engineering (with special reference to dyeworks machinery). The work of this department in the future, and especially when the new buildings are available, will cover a much wider field than the dyeing trade, and will deal with all the chemical industries of the neighbourhood, but the same principle will operate, and every new branch that is opened and every fresh class that is started will have a direct bearing upon some local industry. Some of the new lines of work are supplementary to the other departments. Thus, teaching in bacteriology forms part of the

FIG. 2.—Dyehouse of the Department of Chemistry and Dyeing, Bradford Municipal Technical College.

civil and sanitary engineering classes, and metallurgy—for which a laboratory is to be built and a lecturer appointed—will be taken by mechanical engineering students. Botany, biology and microscopy are sciences which have a direct bearing on many of Bradford's industries, and they have also been taken up. The evening classes consist of specialised courses in chemistry and dyeing for advanced students and persons already engaged in trade.

Engineering Department.

The work of the engineering department, which is under Mr. G. F. Charnock, is divided into four sections, viz. (1) civil engineering, (2) mechanical engineering, (3) electrical engineering, and (4) building trades and architecture, the last named being in conjunction with the art department. Some much-needed additions to the machinery are to be made. Several new machine tools have been ordered, and, as opportunity offers, it is intended to substitute the newest examples for all machines of an old-fashioned type. The new syllabus in civil engineering has been framed to meet the requirements of the various professional bodies. A special feature is to be made of sanitary work, and some attention, including laboratory work, will be given to the new methods of sewage treatment. The mechanical engineering department has an increasingly important part to play in the industrial life of Bradford, and by no means the least important part of the work of this department will be to assist in training up a class of men suitable for the position of power superintendent in mills and factories. In the development of new ideas the department has also its place. The systematic study of mechanism and the method of designing mechanical motions would enable many a good idea which would otherwise be lost to its inventor to be worked out to a successful issue. Almost every technical school of any note on the Continent and in America has its collection of models systematically arranged to lead up from the simplest motions to the most complicated contrivances, but Bradford as yet can give the inventor no such aid.

Arrangements have been made for the proper teaching of electrical engineering, and a laboratory has been fitted up for practical work.

A room has also been reserved as a mathematical laboratory, and is fitted with apparatus and models to render the teaching as concrete as possible. Special attention is given to the slide rule, and there is a useful collection of measuring instruments. A calculating machine and other similar apparatus have also been provided.

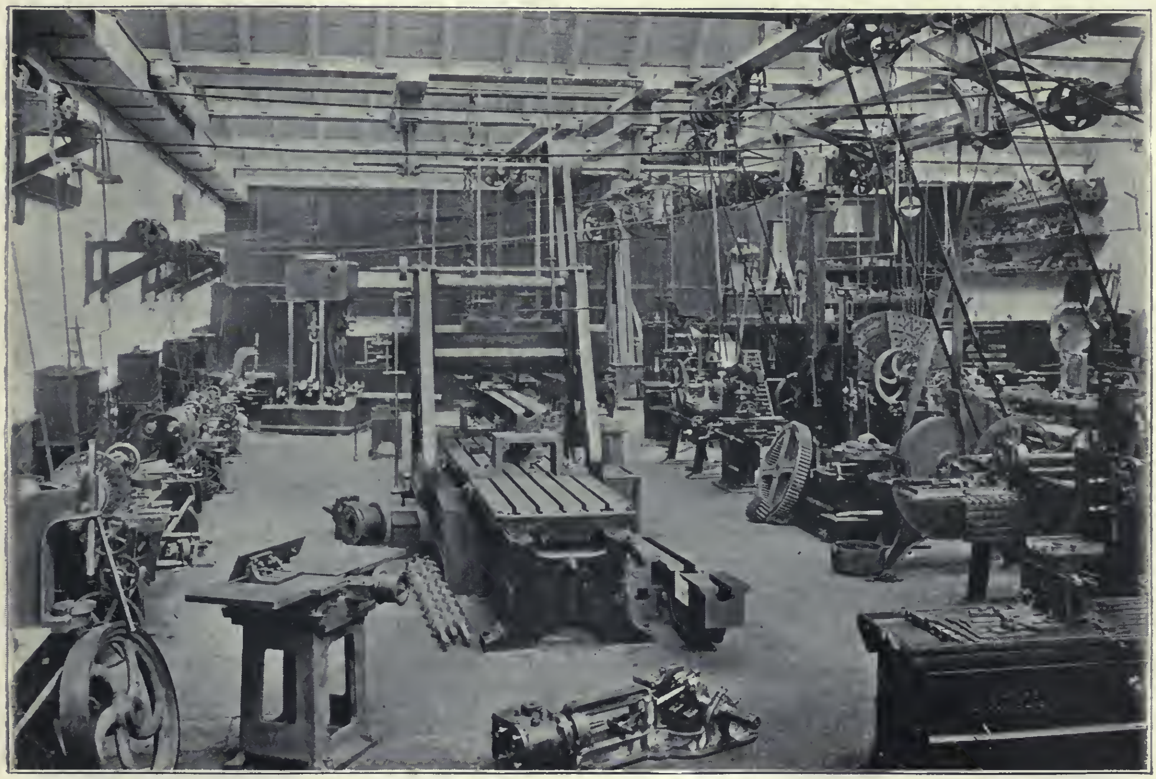


FIG. 3.—Workshop of the Department of Civil and Mechanical Engineering, Bradford Municipal Technical College.

A SUSPENDED RAILWAY.

THE curious railway represented in the accompanying illustration from *La Nature* runs from Vohwinkel to Barmen, through Elberfeld, along the Wupper Valley, in Rhenish Prussia. It is now working regularly, and was to have been formally opened recently by the Emperor of Germany, but the ceremony was postponed on account of the illness of the Empress Frederick. Brief descriptions of the railway have been given in several periodicals, and an illustrated account appears in the October number of the *English Illustrated Magazine*, from which some of the following particulars have been derived.

The total length of the railway is about 8¼ miles, of which more than three-quarters is over the river Wupper. The railway is supported above the river on A-shaped trestles, with the sides rising from each bank, and are placed at intervals of 30 metres. In the highway, along the roads, the supports take the form of an inverted U. The lower part of the latticed girders at the top of the supports contains the rail from which the carriages are suspended. Upon the upper face of this rail runs a two-wheeled truck or trolley containing the electric motors. Two of these trucks, placed nearly thirty feet apart, are supplied to each carriage. From each truck a heavy hook, fastened to the roof of the carriage, projects round the rail, as

shown in Fig. 1. Although the trolley runs on a single rail, it is prevented from falling over by the hook, and also by the fact that the centre of gravity is immediately below the wheels. The railway is a double track, one line for the up and the other for the down trains.

The curve of the track has an average radius of 90 metres; at Vohwinkel, however, there is a curve with a radius of 30 metres, and in one place the radius of curvature is much less than this. At each terminus of the line the track is built in the shape of a large loop, so that the arriving carriages may pass round to the departure platforms. The inclines are slight, the greatest gradient being 4·5 in 100.

The cars are propelled electrically, by current conveyed by means of a sliding contact from generating stations to motors on the trucks supporting the cars. Each truck has a motor of 30 horse-power, and works at a pressure of 600 volts. The cars themselves are about thirty feet long and are of the corridor pattern. There are two cars to a train, and each can carry fifty passengers. No less than nineteen stations are provided in the length of eight miles traversed by the line, and the trains succeed one another every two or three minutes.

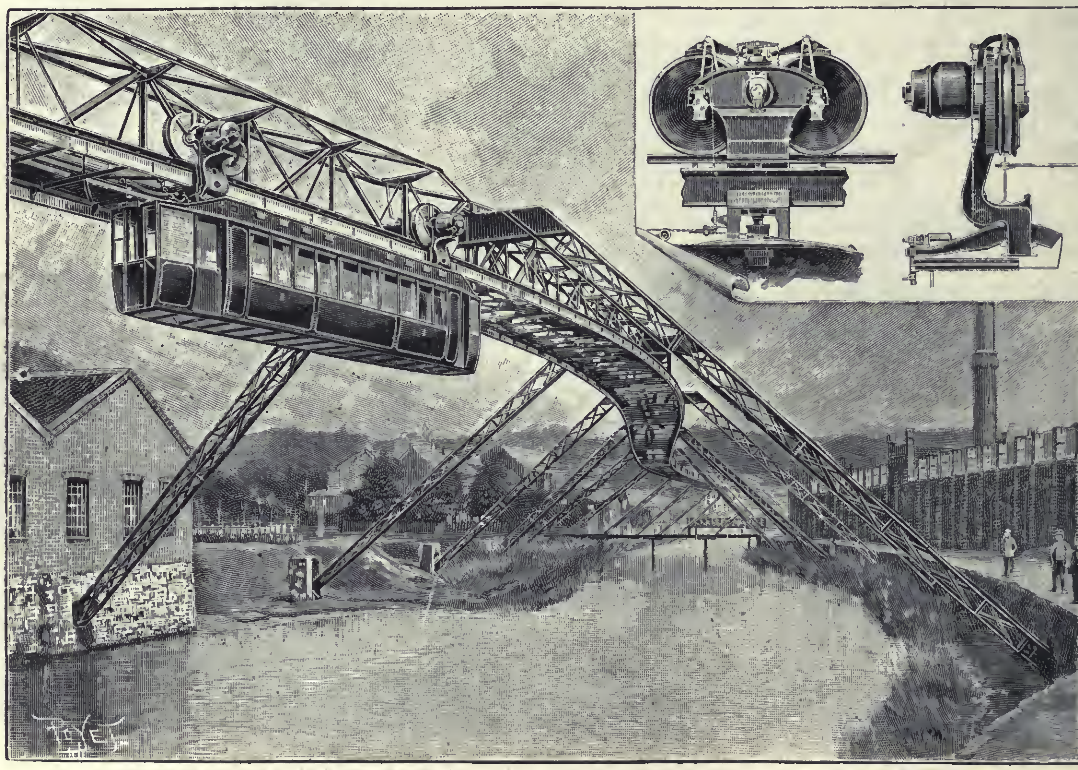


FIG. 1.—General view of a part of the Wupper Valley Railway at Elberfeld. The system of suspension of the trucks is shown in the small figure.

Each car is fitted with a Westinghouse pneumatic brake, a hand brake and an electrical brake, so that it is well under control. The cost of the railway, comprising stations, permanent way, and rolling stock, is stated to have been 56,000*l.* per mile. The proprietor of the railway was Herr Eugene Langen, of Cologne, who died before the line was completed.

OUTPUT AND VALUE OF BRITISH MINERALS.[1]

THE most striking fact recorded in the mineral statistics for 1899 is the enormous output of coal, viz., 220,094,781 tons, showing an increase of 18,040,265 tons compared with the previous year. This country is now producing twice as much coal as it did in 1870, and probably nearly four times as much as in 1850. Durham and Yorkshire together are now yielding about as much coal as the whole of the United Kingdom half a century ago.

The unsatisfactory part of the particulars is the deficiency of detail concerning our most important minerals, coal and iron ore. County outputs are given, but no further descent into local details is permissible, because the Coal Mines Regulation Act prohibits the publication of the individual annual returns. While a statement is made of the output of every little lead or tin mine, it is impossible to state officially which of our colliery companies can be compared, for instance, with such great undertakings as those at Anzin and Lens on the other side of the Channel. Is it wise that no particulars should be kept of the gradual depletion of our great national treasure? The total yearly shrinkage is recorded, but no account is kept in our official statistics of each individual vault which is being drained of its riches.

The Mineral Statistics Committee in 1894 recommended the amendment of the Statute and the publication of the output of individual collieries, but at present nothing has been done. The anomaly involved in the present state of things is specially marked in the case of our iron ores. The law prohibits the publication of the returns of *stratified* ironstone, but allows it in the case of *unstratified* iron ore. Consequently, full details are given of the amount of ore produced by each iron mine in Cumberland, whilst information concerning the output of individual mines in the Cleveland district has to be withheld from publication.

Apart, however, from the question of the production of individual mines, the total output for the year, amounting to more than 220 million of tons and showing an increase of about 9 per cent. on the output for the previous year, points to the urgency which the question of the exhaustion of the coal supply is rapidly assuming. While it is impossible, in an annual report on the mineral output, to undertake the task of estimating the amount of coal still remaining in the British Isles, and of attempting to arrive at any conclusion as to the time that may elapse before its exhaustion begins to be felt, it may perhaps not be out of place to call attention to the practical importance of

[1] Reprinted from a report by Prof. Le Neve Foster, F.R.S., on the output and value of the minerals raised in the United Kingdom in 1899, the amount and value of the metals produced, and the exports and imports of minerals. Published by the Home Office.

checking its present thriftless use. Prof. Perry pointed out a few weeks ago to the members of the British Association for the Advancement of Science that the best steam engines are utilising only one-twelfth of the energy available by the combustion of the fuel, while the ordinary steam engines utilise a far less proportion. Whether our coal supply is sufficient to last for some centuries, or whether, as is the opinion of many competent authorities, a serious coal famine will begin to be felt within the lives of the present generation, economy in the use of coal is unquestionably of the utmost importance, and the investigation of the best means of effecting such economy would repay even a large expenditure, whether by the Government or by industrial corporations and technical societies. If the result of such inquiry were merely to effect an economy of one per cent. in the consumption of coal this would mean an annual saving to the coal consumers of this country of nearly $1\frac{3}{4}$ million tons, worth at last year's prices about £625,000.

Such an investigation might also deal specially with the question of the supply of coal for the Navy. At present certain classes of coal, which with little or no effort on the part of the stoker can be burned without the production of smoke, are specially used for steamships and are often known by the name of "steam coal." If any means can be devised, by investigation and experiment, by which other classes of coal can be burned smokelessly, as is surely possible, our ships will no longer be dependent upon one class of fuel, the naval coal bills will be lessened, and the danger of the failure of coal available for naval purposes will arise only when the total coal supply of the country approaches the point of exhaustion.

Another matter of interest in the present statistics is the increase of the exportation of coal. The quantity of coal exported in 1899 (exclusive of coke and patent fuel) was more than 41 million tons—an amount more than the whole output of coal in any country in the world except the United States and Germany. Of this export more than three-sevenths in quantity and almost half in value is from the South Wales ports. In 1898 and also in 1897 the export was only a little over 35 millions. For the purpose of comparison it is better to take the year 1897, as the quantities dealt with in 1898 were disturbed by the coal strike. Compared with the former year there has been an increase of nearly 6 millions in the total export, and this increase is almost entirely in the export to foreign countries, the export to the British Colonies and Possessions having increased by only 200,000 tons. The countries whose purchases of coal show the largest increase are Russia (which has increased its purchase by nearly $1\frac{1}{2}$ millions), France (more than 1 million), Sweden ($\frac{3}{4}$ million), Italy and Holland. The exports to Germany, Spain, Egypt and South America show only a small increase. The export to the United States is inconsiderable, amounting only to 119,000 tons, chiefly to ports on the Pacific. Among the British Colonies and Possessions there is a considerable increase in the export to India, and some increase in that to South Africa; elsewhere the tendency is rather to decrease.

It must not be assumed that the whole of the coal exported to foreign countries was consumed by foreign nations. Some of it was merely shipped to foreign ports and there utilised for recoaling English steamers. What proportion was so employed does not appear from any statistics that are available, though possibly some indication may be gathered from the amounts sent to Malta, Gibraltar, and Aden, whieh in 1899 were respectively 418,000, 326,000, and 176,000 tons.

As regards minerals other than coal, the increasing importance of aluminium may be noted. The output of this metal now amounts to 550 tons, with a value of 71,125*l*. The output thus approaches in quantity nearly to that of copper, while the value is considerably greater. In spite of higher prices, copper, lead and tin show diminished outputs.

The total value of all minerals raised approaches 100,000,000*l*. sterling, the increase of 20,000,000*l*. compared with 1898 being mainly due to the enhanced value of coal. With our present output, a rise of one penny in the price of coal represents nearly one million of money.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An election to an Isaac Newton Studentship in astronomy and astronomical physics will be held next term. The studentship is worth 200*l*. a year for three years. Candidates must be Bachelors of Arts who are under twenty-five on January 1, 1900.

Mr. H. F. Baker, F.R.S., of St. John's College, has been appointed University Lecturer in Mathematics.

At the biennial election to the Council of the Senate on November 7, the following new members were returned: Dr. Ryle, Dr. Taylor, Prof. Ridgeway, Mr. R. F. Scott, St. John's.

Science states that a bronze medallion with a likeness of Prof. Sylvester will hereafter be awarded as a mathematical prize at the Johns Hopkins University.

DR. LORENZ, of the University at Halle, has been made director of the physical and technological institute of the University of Göttingen.

THE following appointments have recently been made at University College, Sheffield. Dr. S. R. Milner, late junior demonstrator in physics at Owens College, to be demonstrator and assistant lecturer in physics. Dr. T. S. Price to be additional demonstrator in chemistry.

MR. E. J RUSSELL, assistant lecturer and demonstrator at the Owens College, has been appointed lecturer in chemistry at the South-Eastern Agricultural College in succession to Mr. H. H. Cousins, who has been appointed agricultural chemist to the Government of Jamaica.

CALENDARS of University Colleges are all built upon much the same pattern, but each has some noteworthy characteristics. For instance, we see that the Durham College of Science, Newcastle-upon-Tyne, like one or two similar institutions, has a marine biological laboratory available for its students at Cullercoats. The agricultural department has been well organised, and is entrusted with the scientific direction of the farm acquired for the purpose of demonstration and experiment by the County Council of Northumberland. Opportunity is afforded to qualified students to undertake original work in all departments, and the students are permitted to visit chemical and other works in the district. Prof. Louis is to deliver a special course this session for the instruction of persons proceeding to any of the gold-fields. The course will deal with prospecting for gold, the methods of extraction of gold from its ores, and the assaying of gold ore and bullion. A scheme is on foot for the establishment of a new northern university based on the Durham College, on the model of that founded at Birmingham upon Mason College.

A SCHEME of agricultural education, which Mr. A. N. Pearson has drawn up for Victoria, in connection with the Royal Commission on Technical Education, is founded on the principles which are now accepted to form the only permanent basis for scientific instruction: viz. that natural knowledge only comes by individual experience in the school of nature. Many elementary facts of agriculture lend themselves readily to educational purposes, and by employing them in a proper way it is possible to give young pupils an intelligent view of natural processes which will be of value in the practical work of later life. With a few seeds it is easy to study germination and the growth and structure of root and stem. Simple examinations of soils may follow, and then determinations of the composition of plants. After this, there would be but a short step to an elementary knowledge of the chemical composition of soils and of commercial plant foods, and the pupil could make intelligent use of the latter, either in growing pot plants, or in cultivating small garden plots. Mr. Pearson gives in his report a scheme for the education of youths in agricultural colleges and farm-schools, and he shows that he is inspired with the spirit of true education. By adopting such a scheme of work as he suggests, the Government of Victoria will show foresight for the future welfare of the colony, and will make its methods of agricultural instruction equal to the best.

FATHER A. L. CORTIE, S.J., discoursed on the teaching of science in Catholic Schools at the last conference of Catholic Colleges on Secondary Education; and his paper is given in full in the official report just received. The fundamental note of his remarks is that classics and mathematics ought to be the foundation of our educational structure, and the "finish and polish of a course of science" should be put upon it afterwards. It is suggested that scientific men wish to oust the classics, and substitute a merely commercial and scientific education as the mental training of the boy intended for trade and the practical walks of life. This, however, scarcely expresses the real state of the case, for many scientific men are familiar with classical literature and would be sorry to see it neglected. But can the same be said of classical men as a rule: are they inclined to give science a proper

place in their educational curricula? A glance at the Time Table of any Public School, and of most Grammar Schools, or at a list of scholarships available at Universities, will show that science is the Cinderella in secondary schools, and its presence is more tolerated than encouraged. When science (rationally taught, of course) takes so many hours of a boy's school work as classics, it will be time to suggest that the languages of ancient Greece and Rome are being ousted. Father Cortie's views as to the plan and method of science teaching may be judged from the final remarks from his paper:—"Our aim in teaching science, as in teaching every other subject to the boys committed to our charge, ought to be chiefly directed to training the mind, and not to the imparting of a number of isolated and disconnected facts. I would advocate in the first place a preliminary course of classical and literary training before joining the science classes, and secondly that in the science course itself the training should be neither wholly didactic, nor yet wholly experimental, or Heuristic, to employ the term so much in fashion at present, but a judicious mixture of both. A cultured mind should be the outcome of our training, in science, as in other subjects. And for true culture, a knowledge of facts, in lieu of knowledge of principles and methods, is worthless."

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 9.—Prof. A. W. Reinold, F.R.S., Vice-President, in the chair.—Dr. R. A. Lehfeldt read a paper on "Electro-motive force and osmotic pressure." This paper is an attempt to explain a difficulty in the interpretation of the ordinary logarithmic formula for the E.M.F. between a metal and solution, pointed out by the author at the Dover meeting of the British Association. An expression for the E.M.F. of a concentration cell is obtained thermo-dynamically upon the assumption that the electrolyte is only partially dissociated. A partition is used which is permeable to water but not to the salt or its ions, and the conclusion follows that the E.M.F. depends, not on the osmotic pressure of the metallic ions, but on that of the solution as a whole. A graphical representation is given plotting osmotic pressure against dilution, assuming Boyle's law to hold, and it is shown that the E.M.F. is not proportional to the integral $\int PdV$ but to the converse integral $\int VdP$. Assuming, further, that the osmotic pressure changes according to Van der Waals's equation, the E.M.F. is greater than that calculated from Boyle's Law. If the electrolytic solution pressure is calculated from the integral $\int PdV$ it comes out 10^{19} atmospheres; but if from the converse integral, the value obtained is about 20,000 atmospheres. A comparison between actual E.M.F.'s and those derived from the equation given by the author should afford, if the formula is correctly deduced from the assumptions made, a measure of how far the osmotic pressure deviates from that indicated by Boyle's law. Experiments upon concentration cells have been made by Helmholtz, Wright and Thomson, Moser, Lussana and Goodwin; but as their work was performed upon cells with migration of ions, the calculation of the osmotic pressure is rendered uncertain by the introduction of the transference ratio. Accordingly the author has measured the E.M.F.'s of cells without migration, using zinc as electrodes and chloride and sulphate of zinc as salts. The E.M.F. was measured by the compensation method, using a post office box through which a current was sent by an accumulator. The accumulator kept up a constant potential difference, and was standardised daily by means of a Clarke cell. The experimental results agree with the calculated over the range centi- to deci-normal, showing that the deviation from the value given by the logarithmic formula is accounted for by the incomplete dissociation of the salts. The osmotic pressures are then calculated from the E.M.F.'s and the values of PV plotted. They show irregularities due to the combined effect of the decreasing dissociation of the salt and the increasing departure from Boyle's Law. Dividing the product PV by Van 't Hoff's factor, determined from conductivity, values are obtained showing variations similar to those observed in the behaviour of gases when subjected to high pressure. Mr. Whetham said there was one form of membrane which is quite permeable to water and yet does not allow either salts or the ions to get through. He referred to the free surface of the solution itself. The water being volatile can get out, but the salt cannot. Dr. Donnan said the author seemed to have discovered things well known; for instance, the integral $\int VdP$ is generally taken as proportional to E.M.F. He expressed his interest in the explanation of the difficulty in the logarithmic formula. Dr. Lehfeldt, in reply, said Goodwin had used the integral $\int VdP$ but had not made any numerical calculations by means of it. —Mr. R. J. Sowter read a paper on "astigmatic lenses." An astigmatic lens is one which so acts on rays of light falling on it as to produce, in general, two focal lines in the refracted ray system. A lens derived from a quadric surface is the general elementary type of astigmatic lens, and in the paper an ellipsoidal lens is selected and considered. The focal lines are parallel to the elliptic axes, and correspond to the lens powers in these directions. These powers are proportional to the inverse squares of the axes. A curve drawn through all points on a lens where the material thickness is constant may be said to determine a natural aperture for that lens. A method of natural apertures is employed to establish the various relation set out in the paper. An ellipse is the natural aperture for an ellipsoidal lens, a circle for a spherical lens, and an infinitely long rectangle for a cylindrical lens. It is shown that two cylindrical lenses crossed at right angles are equivalent to an ellipsoidal lens, and the power of the combination in any direction is the same as that of the ellipsoidal lens in that direction. It is also shown that two obliquely crossed cylindrical lenses are equivalent to an ellipsoidal lens, or to two cylindrical lenses of definite powers crossed at right angles, or to a cylindrical and a spherical lens; for a spherical lens may be replaced by two equal cylindrical lenses crossed at right angles. Prof. S. P. Thompson said he had never seen the treatment of an ellipsoidal lens before, although the extreme case of a paraboloidal lens had been considered. The author's method was, as far as he knew, new, and would be very convenient to work with. Mr. A. Campbell then read the following papers:—(*a*) "On a phase-turning apparatus for use with electrostatic voltmeters." Electrostatic voltmeters are particularly insensitive at the lower parts of their ranges, the divisions closing in very much towards the zero point. When measurements of small direct-current potential differences have to be made, it is an easy matter to add to the voltage to be measured a constant voltage large enough to bring the deflection to an open part of the scale. If the small voltage to be measured is an alternating one, it is necessary that the auxiliary voltage should alternate with the same frequency, and be in phase with it. The apparatus described enables the phase of the auxiliary voltage to be turned until it agrees with the one to be measured. The phase difference referred to is not the time lag but the angle whose cosine is the power factor and may be called the power lag. The method is to get two independent equal voltages, U_1 and U_2, differing in power phase by $\frac{\pi}{2}$, and to add together suitable fractions of these, such as $U_1 \sin \phi$, $U_2 \cos \phi$. The resultant is equal to U_1, but with the power phase turned through ϕ. The unknown small voltage is connected in series with an auxiliary voltage and a voltmeter, and the phase of the latter voltage is turned until the maximum deflection is obtained. (*b*) "On a method of measuring power in alternating current circuits." The circuit in which the power is to be measured is connected in series across the supply circuit with a small non-inductive resistance. By means of a transformer the small voltage on this resistance may be transformed into one whose power phase is π behind the voltage on the resistance. This is added to the voltage on the circuit to be measured, and then reversed and added again. The difference of the squares of these effective resultants is shown to be equal to a constant into the power to be measured. If there is any direct current, it must be measured separately by a Weston voltmeter or other suitable instrument. (*c*) "Note on obtaining alternating currents and voltages in the same phase for fictitious loads." When testing instruments for the measurement of large amounts of electrical power or energy, it is usually desirable to do so by means of fictitious loads, or by applying to the instrument under test current and potential difference representing the required load. In order to obtain a fictitious non-inductive load with alternating currents, the potential difference and current should be in the same phase. The current for the

instrument under test is got by means of a transformer worked on a hundred volt circuit. The potential difference in the same phase is got by allowing the current to flow through a non-inductive resistance and increasing the voltage at the ends of the resistance to the required amount by means of another transformer.—The Society then adjourned until November 23.

Chemical Society, November 1.—Prof. Thorpe, President, in the chair.—The following papers were read:—Action of alkalis on nitro-compounds of the paraffin series. Part 2: The reactions and constitutions of methazonic acid and the formation of isoxazoles, by W. R. Dunstan and E. Goulding. On treating nitromethane with alkalis, a mono-basic acid, methazonic acid, $C_2H_4N_2O_3$, is produced; when heated with acids or alkalis it decomposes into carbon dioxide, hydrogen cyanide, and hydroxylamine. The authors attribute the constitution

```
         CH2.NH
          |   |
  HO.N:C—-O
          ||
          O
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to methazonic acid.—Hexachlorides of benzonitrile, benzamide and benzoic acid, by F. E. Matthews. Chlorine water in presence of light converts benzonitrile into a crystalline hexachloride, $C_6H_5Cl_6.CN$, which, when heated with sulphuric acid at 170—180°, is converted into the hexachloride of benzamide; the latter is oxidised by fuming nitric acid yielding benzoic acid hexachloride, $C_6H_5Cl_6.COOH$.—The influence of solvents on the rotation of optically active compounds, 1, by T. S. Patterson. As the result of experimental work on ethyl tartrate, the author traces the variation of rotatory power with solvent to the variation of the asymmetry of the molecule owing to changes of the internal pressure in the solution.—The action of heat on ethyl sulphuric acid, by W. Ramsay and G. Rudorf. Ethyl hydrogen sulphate yields, when heated, sulphur dioxide, carbon dioxide, carbon monoxide and ethylene, as gaseous decomposition products.—Contributions to the knowledge of fluorescent substances: (1) The nitro-derivatives of fluorescein, by J. T. Hewitt and B. W. Perkins. Anhydrous dinitrofluorescein is not fluorescent in soda solution; the authors are unable to confirm von Baeyer's analytical numbers for tetranitrofluorescein, and suggest the composition $C_{20}H_{10}(NO_2)_4O_6$ for this substance.—Derivatives of ethyl α-methyl-β-phenylcyanglutarate, by W. Carter and W. T. Lawrence. Ethyl cinnamate and ethyl sodiocyanacetate interact in alcoholic solution and, on adding methyl iodide to the product, the two stereoisomeric forms of ethyl α-methyl-β-phenyl-α-cyanglutarate are produced; derivatives of these substances are described.—The nitration of acetamino-orthophenyl acetate (diacetylorthoaminophenol). A correction, by R. Meldola and E. Wechsler.—Rhamnazin and rhamnetin, by A. G. Perkin and J. R. Allison. The authors show that rhamnazin is a methoxyrhamnetin and that rhamnetin has the following constitution:—

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CH3O.C—CH=C.CO—--C——C—-CH:C.OH
      ||     |      ||   ||     |
   HC.C(OH):C.C(CO).C.OHCH.CH:C.OH.
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—Luteolin, 3, by A. G. Perkin and L. H. Horsfall.—Genistein, 2, by A. G. Perkin and L. H. Horsfall.—The colouring matter of the flowers of *Delphinium consolida*, by A. G. Perkin and E. J. Wilkinson. The yellow colouring matter in these flowers is present as a glucoside, and has the composition $C_{15}H_{10}C_6$; it yields phloroglucinol and p-hydroxybenzoic acid on fusion with potash.—Note on Gallinek's amidomethylnaphthimidazole, by R. Meldola and F. W. Streatfeild.—The amount of chlorine in rain-water collected at Cirencester, by E. Kinch.—Researches on the alkyl-substituted succinic acids: (3) Dissociation constants, by W. A. Bone and C. H. G. Sprankling. The authors have determined the dissociation constants of a number of new di-alkyl-substituted succinic acids, and show that as the mass of a normal alkyl-substituting group increases the dissociation constant also increases; in the case of 'iso' substituting radicles, however, there is a structural effect opposed to that of mass.—The reaction between ethyl alcohol and hydrochloric acid, by T. S. Price. The author has determined the velocity of reaction between ethyl alcohol aud hydrochloric acid, and finds that the velocity increases very rapidly with rise of temperature.

Royal Microscopical Society, October 17.—Mr. Carruthers, F.R.S., President, in the chair.—Dr. Hebb brought before the notice of the meeting samples of stains for microscopic specimens, prepared by Messrs. Burroughs, Wellcome and Co. The stains were in a solid form, each "soloid," as they are termed, containing a definite amount of the staining reagent. The advantages of this form of preparation are simplicity and economy.—Messrs. R. and J. Beck exhibited a new pattern students' microscope. It was of the continental form, and was chiefly noticeable for its cheapness, which was attained without sacrifice of quality by adopting an improved method of manufacture. It was called the "London" microscope, and had rack and pinion coarse adjustment, perfect micrometer screw fine adjustment, vulcanite top stage, iris diaphragm in sliding tube, and spiral substage fitting.—Mr. F. W. Watson Baker gave an exhibition of slides and models illustrating the structure and development of the skin.—The Secretary announced that Mr. Millett had forwarded Part ix. of his report on the Foraminifera of the Malay Archipelago, which would be taken as read; the paper appears in the current number of the *Journal* of the Society.

MANCHESTER.

Literary and Philosophical Society, October 16.—Prof. Horace Lamb, F.R.S., President, in the chair.—Prof. H. B. Dixon, F.R.S., gave a summary of the results of experiments, conducted by himself and Mr. F. W. Rixon, on the specific heat of gases at high temperatures. As part of a larger investigation, the authors have determined directly the specific heat of carbonic acid, up to 400° C., at constant volume. The gas is screwed up in a mild steel cylinder, which is heated in a gas-oven running on rails. The oven and cylinder can thus be brought quickly over the calorimeter, into which the cylinder falls through trap-doors forming the bottom of the oven. The transference is thus effected with a minimum loss of heat. The difficulties arising from splashing and from escape of steam are overcome by dropping the cylinder into a glass tube dipping some distance below the water. The glass tube breaks at a crack made in the neck, and thus ensures a complete immersion of the hot cylinder at a good depth in the water, which closes over the cylinder in a cataract. A similar experiment being performed with the empty cylinder, the difference gives the heating effect of the gas. The results given below for CO_2 show that the method, which, it is hoped, may yet be improved, is a workable one:

Initial temperature of gas	Final temperature	Mean	Specific heat
115	16	65·5	·200
192	16	104	·211
298	21	159·5	·288
398	21	209·5	·356

The authors are now measuring the specific heat of nitrogen in the same way.

PARIS.

Academy of Sciences, November 5.—M. Maurice Lévy in the chair.—On the velocity of light, by M. Perrotin. A redetermination of the velocity of light by Fizeau's method. The distance between the two stations was nearly 12 kilometres, and the mean result of about 1500 observations by two observers was 299,900 kilometres per second.—On the latest results obtained in the study of the infra-red part of the solar spectrum, by M. S. P. Langley. The author has been able to extend his previous researches on this subject in two directions, firstly by increasing the sensibility of the bolometer, and secondly by taking the observations at a great altitude, about 13,000 feet. By reason of the remarkable purity of the atmosphere at this height, a region of the spectrum has been discovered beyond the extreme point attained by previous observers. The tables now issued contain about 600 lines, 400 of which are new. The paper is accompanied by a whole page illustration.—Remarks on the preceeding communication, by M. J. Janssen. Attention is drawn to the effect of season upon the lines observed. By working at a high altitude some telluric lines may be eliminated.—On a class of algebraic surfaces, by MM. G. Castelnuovo and F. Enriques. On the topographical correction of pendulum observations, by M. J. Collet.—Acetals of polyvalent alcohols, by M. Marcel Delépine. Determinations of the heats of combustion of the formals and acetals of glycol, erythrol and mannitol.—Constitution of the nitro-derivatives of ethyl dimethylacrylate, by MM.

L. Bouveault and A. Wahl. The nitro-derivative previously described is split up by ammonia, giving acetone and ethyl nitro-acetate.—On the simultaneous presence of saccharose and gentianose in the fresh root of the gentian, by MM. Em. Bourquelot and H. Hérissey.—Note on a new glucoside extracted from the seeds of *Erysimum*, belonging to the Cruciferæ, by MM. Schlagenhauffen and Reeb. A description of the isolation, chemical and physiological properties of a new glucoside isolated from Erysimum, to which the name erysimine is given.—The distribution of the sexes in the eggs of pigeons, by M. L. Guènot. It is shown that the view commonly held concerning the distribution of the sexes in the two eggs of the pigeon is not supported by experiment, the relations found corresponding perfectly with those calculated from the law of chances.—Contributions to the study of the phenomena of metamorphosis in the Diptera, by M. C. Vaney.—Sexual reproduction in *Ophrycystis*, by M. Louis Léger.—On the parasitism of *Ximenia americana*, by M. Edouard Heckel.—On gaseous projectiles proposed for the prevention of hail, by MM. G. Gastine and V. Vermorel.

NEW SOUTH WALES.

Linnean Society, August 29.—The President, the Hon. James Norton, in the chair.—Descriptions of some new *Araneidae* of New South Wales, by W. J. Rainbow. This paper contains descriptions of four new species, and one well-marked variety of a previously described form. Of the forms described, one is referable to the genus *Dysdera*, Latr., and is consequently a new generic record for Australia. For this species the author proposes the name *D. australiensis*. Other forms described are *Tama eucalypti*, *Araneus parvulus*, *A. singularis*, and *Dicrostichus furcatus*, Camb., var. *distinctus*.—Studies on Australian Mollusca, Part ii., by C. Hedley. Several new marine shells from Queensland and New South Wales are described, including species of *Chlamys*, *Puncturella*, *Terebra*, *Leucotina* and *Liotia*. Two plates which accompany the article illustrate these, together with species named by Tenison-Woods, Brazier and Beddome, but not before figured. The genus *Menon* published in Part i. is shown to be reducible to *Chileutomia*, Tate and Cossmann, hitherto known only as an Eocene fossil. Notes on habits, geographical range and synonymy of known forms conclude the article.—Notes to accompany figures of Boisduval's types of six species of Australian *Curculionidae*, by Arthur M. Lea. With the co-operation of Monsieur P. Lesne, of the Paris Museum, the endeavour is made to clear up matters relating to the following species:—*Cryptorrhynchus dromedarius*, *C. lithodermus*, *C. fuliginosus*, *C. ephippiger*, *Gonipterus recticulatus* and *G. notographus*. The types are in the Brussels Museum, and have been examined by M. Lesne, who has forwarded his notes and sketches.—Contributions to the morphology and development of the female urogenital organs in the *Marsupialia*, Nos. ii.–v., by Jas. P. Hill.—Descriptions of two new species of Phytophagous Hymenoptera referable to the families *Oryssidae* and *Tenthredinidae*, with notes on other saw-flies, by Gilbert Turner. A species of *Oryssus*, a genus not hitherto recorded from Australia, and one of *Clarissa* are described, both from Mackay, Q. In the same locality the author has also collected five species of *Perga*, one of *Hylotoma*, four of *Pterygophorus*, and one of *Clarissa*.—On the measurement of bacteria, by R. Greig Smith. The measurement of the breadth of bacteria by the eye-piece micrometer is uncertain because the unit of measurement (one division) is generally larger than the object measured. The author has tabulated a number of diagrammatic bacteria, the breadth of which is expressed in terms of the length.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 15.

ROYAL SOCIETY, at 4.30.—Argon and its Companions: Prof. Ramsay, F.R.S., and Dr. Travers.—Data for the Problem of Evolution in Man. VI. A First Study of the Correlation of the Human Skull: Dr. Alice Lee and Prof. K. Pearson, F.R.S.—Mathematical Contributions to the Theory of Evolution. IX. On the Principle of Homotyposis and its Relation to Heredity, to the Variability of the Individual and to that of the Race. Part I. Homotyposis in the Vegetable Kingdom: Prof. K. Pearson, F.R.S.—A Chemical Study of the Phosphoric Acid and Potash Contents of the Wheat Soils of Broadbalk Field, Rothamsted: Dr. B. Dyer.

LINNEAN SOCIETY, at 8.—Contributions to the Comparative Anatomy of the Cycadaceæ: W. C. Worsdell.—On a New Parasitic Copepod: Miss Alice L. Embleton.

CHEMICAL SOCIETY, at 8.—The Bases contained in Scottish Shale Oil: F. C. Garrett and Dr. J. A. Smythe.

FRIDAY, NOVEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Capacity of Railway Waggons as affecting Cost of Transport: D. Twinberrow.

ANATOMICAL SOCIETY, at 4.30.—Notes on the Hair-slope in Man: Dr. Walter Kidd.—The Origin of the Vertebrate Eyes and the Meaning of the Second Pair of Cranial Nerves: Dr. W. H. Gaskell, F.R.S.

TUESDAY, NOVEMBER 20.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions towards a Knowledge of the Osteology of the Pigmy Whale (*Neobalaena marginata*: F. E. Beddard, F.R.S.—A Description of *Wynyardia bassiana*, a Fossil Marsupial from the Tertiary Beds of Table Cape, Tasmania: Prof. Baldwin Spencer.—On some Crustaceans from the South Pacific. Part V. Arthrostracans and Barnacles: L. A. Borradaile.—List of Mammals obtained by Dr. Donaldson Smith during his Recent Journey from Lake Rudolf to the Upper Nile: Oldfield Thomas.

ROYAL STATISTICAL SOCIETY, at 5.—On the Distribution of Population in England and Wales, and its Progress in the Period of Ninety Years, from 1801 to 1891: T. A. Welton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: The Metropolitan Terminus of the Great Central Railway: G. A. Hobson and E. Wragge.—*Paper to be read, time permitting*: Machinery for the Manufacture of Smokeless Powder: Oscar Guttmann.

WEDNESDAY, NOVEMBER 21.

SOCIETY OF ARTS, at 8.—Opening Address of the 147th Session, by Sir John Evans, K.C.B., F.R.S.

GEOLOGICAL SOCIETY, at 8.—On a Monchiquite from Mount Girnar, Junagarh (Kathiawar): Dr. J. W. Evans.—On some Altered Tufaceous Rhyolitic Rocks from Dufton Pike (Westmorland): Frank Rutley.—On the Geology of Mynydd y Garn (Anglesea): C A. Matley.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—An Improved Mounting for the Lens and Bowl of the Campbell-Stokes Sunshine Recorder: Richard H. Curtis.—Weekly Death Rate and Temperature Curves, 1890–1899: W. H. Dines.—Seasonal Rainfall of the British Islands: Henry Mellish.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Slides illustrating the Structure of Shells.

ENTOMOLOGICAL SOCIETY, at 8

THURSDAY, NOVEMBER 22.

ROYAL SOCIETY, at 4.30.—*Probable* papers: The Histology of the Cell Wall, with Special Reference to the Mode of Connection of Cells: W. Gardiner, F.RS., and A. W. Hill. Part I. The Distribution and Character of "Connecting Threads" in the Tissues of *Pinus sylvestris* and other Allied Species: A. W. Hill.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telegraphs and Telephones at the Paris Exhibition, 1900: John Gavey.

FRIDAY, NOVEMBER 23.

PHYSICAL SOCIETY, at 5.—The Anomalous Dispersion of Carbon: Prof. R. W. Wood.—The Liquefaction of Hydrogen: M. W. Travers.—On the Refraction of Sound by Wind: Dr. R. H. Barton.

CONTENTS.

THURSDAY, NOVEMBER 22, 1900.

THE CORRESPONDENCE OF BERZELIUS AND SCHÖNBEIN.

The Letters of Jöns Jacob Berzelius and Christian Friedrich Schönbein, 1836–1847. Edited by Georg W. A. Kahlbaum. Translated by Francis V. Darbishire, Ph.D., and N. V. Sidgwick. Pp. 112. (London, Edinburgh and Oxford, Williams and Norgate, 1900.)

IN collecting materials for the life of Schönbein, the first instalment of which has already been noticed in these columns, Dr. Kahlbaum has had placed at his disposal all the correspondence, covering nearly fifty years, left behind him by the illustrious discoverer of ozone and gun-cotton. The letters of Faraday and Liebig have thus been made public, and we have now an English edition of the letters which passed between Berzelius and Schönbein, the original edition in German having been prepared by the editor as a tribute to the memory of Berzelius on the occasion of the commemoration at Stockholm, on October 9, 1898, of the fiftieth anniversary of the death of the great Swedish chemist. The translators have added two of Schönbein's letters written in 1847, and a paper by that author which was not included in the German edition. Of the twenty-two letters published in this little volume eight are by Berzelius.

Berzelius was senior to Schönbein by twenty years, and it appears that the latter had about 1827 resolved to go to Stockholm to complete his studies under the "consummate master of chemical science." In order to raise the necessary funds he offered a London bookseller (Koller) a translation of Berzelius' "Lärbok i Kemien," and about the same time he proposed to a German acquaintance (Perthes, of Gotha) to supply a German translation of Gay-Lussac's lectures on physics, which he was then attending at the Sorbonne. Neither of these schemes came to anything, and Schönbein was, as already recorded in his life, invited to Bâle as temporary professor in 1828. The Swabian chemist thus never came under the personal influence of his Swedish contemporary as a pupil, and the acquaintance was commenced in 1836 by a letter, in which Schönbein submitted the results of his experiments on the passivity of iron. In this letter, which is the first of the present series, he describes himself to Berzelius as "a perfect stranger." The reply, dated May 4, 1837, is interesting, not only because it is the first communication from Berzelius, but also because it at once emphasises the difference of opinion which at that time separated the two schools of "contact" and "chemical" electricians. Having suggested that the iron by contact becomes charged with opposite electricity, he goes on to say:

"But of course you cannot admit the latter assumption, since you accept De la Rive's view that electricity of an opposite character cannot be produced by contact. In this, however, I do not agree with you; I am firmly convinced that when we understand the cause of this remarkable property of iron, we shall find in it one more proof that Volta's conception was more profound and nearer the truth than that of his opponents, who, by admitting that electricity and chemical affinity are different manifestations of the same force, acknowledge, though without being conscious of so doing, that Volta was right."

In subsequent letters the prevailing note of the correspondence is still the origin of the electric current and the cause of polarisation. In his letter of October 14, 1838, Schönbein describes the polarisation of liquid electrodes (hydrochloric acid) in a U-tube, and suggests in explanation that the first step in the decomposition of a molecule by electricity is, as it were, a preliminary loosening of the affinities of the atoms:—"Between the complete separation of two elements and their most intimate chemical union there exist intermediate conditions of combination, of which as yet we know nothing; unless indeed isomerism points to some such relation." Berzelius (November 13, 1838) opposes this view, and refers his correspondent to a theory of the galvanic cell which he had advanced thirty-six years previously. The reference to this theory has apparently given the editor, Dr. Kahlbaum, some trouble, but he appears to have identified it and appends a valuable bibliographical footnote. Schönbein's reply (March 28, 1839) contains further arguments against what he calls the "electrochemical theory," meaning, of course, the form of that theory promulgated by Berzelius. He sums up in the statement that "the act of chemical combination of the elements is not due to the play of electrical forces, or, in other words, that affinity and electricity are not the same thing, though they are mutually dependent."

The first reference to ozone in the present correspondence is contained in a letter from Schönbein to Berzelius dated September 11, 1840, in which he refers to the "odoriferous principle" as having already been discovered but not isolated in sufficient quantity to determine its chemical characters. The reply to this communication, of which a copy by Schönbein has been found, was kept by the Crown Prince, subsequently King Maximilian II. of Bavaria, under somewhat interesting circumstances. It appears that the first paper on ozone had been sent by Schönbein to Prof. Schelling, who was then at Munich, and the latter in his reply says:

"In the person of our Crown Prince we possess a distinguished patron of research, especially on scientific lines. Should you ever be unable from want of pecuniary resources to begin a lengthy research, from which you have grounds for expecting good results, let me know, and it will give me great pleasure to awaken the interest of our generous Prince on your behalf."

On the strength of this recommendation Schönbein applied for a grant in order to purchase a battery; but unfortunately the application was received by the Prince just as he was leaving for Greece, and he took the correspondence, including the letter from Berzelius referred to above, away with him, so that nothing resulted from the application.

Passing on to the year 1844, there is a very long letter addressed to Berzelius and containing a fairly complete *résumé* of Schönbein's work on ozone down to that period. It is of interest to read that he sends his correspondent the bleached strip of paper which first "proved the bleaching power of the electrical odour" on April 7, 1844. In this letter also we find the view that nitrogen is a hydride of ozone, and, in curious antithesis to existing

notions, that "certain diseases might be due to ozone." The reply from Berzelius is chiefly remarkable for the cogency of the reasons which he urges against the view that nitrogen is a constituent of ozone, and the friendly spirit in which he urges Schönbein to follow up his investigation "with true Bunsen perseverance."

The letter from Schönbein dated January 15, 1845, contains an account of the production of an "electro-negative oxidising substance" by the slow combustion of ether vapour and phosphorus, by a hydrogen flame and by a candle flame. This was read to the Academy at Stockholm, and Berzelius in his reply considers his correspondent to have proved that ozone is always formed during combustions in atmospheric air. He then goes on to criticise most frankly some of Schönbein's conclusions in a detailed paper published in 1844, he makes excellent suggestions for testing certain points experimentally, and winds up with the remark :—

"It would, therefore, be better to put on one side all theoretical conjectures as to the constitution of ozone and nitrogen, and to study the properties of ozone itself. When once you have caught it, it will be easier to theorise about it."

In his reply Schönbein explains that much of his correspondent's criticism had arisen from the misrepresentation of his views owing to the bad rendering of his paper into French, but he candidly and gratefully accepts the remainder. He still clings, however, to the possibility of nitrogen being a compound, and adds a remark to the effect that even if this hypothesis were baseless, it had guided him in all his experiments and had led him to many discoveries.

A letter of Schönbein's dated March 22, 1845, is of particular interest from several points of view. It was communicated by Berzelius to the Stockholm Academy, together with another letter from Plantamour, of Geneva, which contained a description of Marignac's first experiments and conclusions respecting ozone. Schönbein in his letter refers also to the work of his friend Marignac, and describes the results to Berzelius. He considered that his and Marignac's experiments confirm one another, and he adds :—

"I think we may fairly conclude from them that oxygen and hydrogen are the constituents of ozone."

Thus he had by that time abandoned the view that nitrogen had anything to do with ozone, and it is quite exciting, even at the present time, to read in this letter how near he was to the explanation of the true nature of ozone, and yet how he missed the path. He gives convincing reasons for believing that ozone and Thénard's hydrogen peroxide were distinct, and he proves by experiment that ozone is destroyed by passing through a hot tube. Yet it seems to have been first suggested by Plantamour, in a letter to Berzelius dated April 20, 1845, that ozone was not a compound, but only a form of oxygen, although in the paper printed as an appendix to the present volume Schönbein speaks of this view as having been originated by De la Rive.

The subsequent letters teem with interest especially when, as in that dated June 20, 1846, the practical applications of gun-cotton begin to figure in the correspondence. The King of Sweden, at the instigation of Berzelius, sent Schönbein the Vasa Medal in February, 1847. On March 12 of that year Berzelius addressed a long letter to Schönbein full of the most friendly and candid criticism of his views on the chemical nature of nitric acid and ozone. From this it appears that Schönbein still believed that ozone contained hydrogen, for his correspondent says :—

"But does ozone really contain hydrogen? This question we can answer most emphatically in the negative. If oxygen gas collected during the last third of its evolution from potassium chlorate be exposed to a series of short electric sparks, ozone is formed just as readily and to precisely the same extent as during the first third of the operation. In this case, however, it is physically impossible for water to be present. This constitutes the most indisputable proof that ozone does not contain hydrogen. Hence it follows that ozone is an allotropic modification of oxygen itself, &c."

The criticisms in this letter are altogether very vigorous, and Berzelius lays down a principle at the outset of his attack which it would have been well to have kept in view in many "modern instances" of theorising :—

"The test of the truth of a theory is that it should harmonise the particular instance with the whole system of science; for the laws of nature are always consistent with one another. Now if you advance a principle which makes an exception of what was before consistent with scientific ideas, logic pronounces against you."

He concludes by begging his correspondent to excuse his preaching, and hopes he will not refuse to learn. It is, no doubt, only a coincidence, but this, the last letter from Berzelius, is the only one in which the Swedish chemist winds up with the subscription, "Farewell, yours sincerely." The reply by Schönbein, dated March 29, 1847, contains a further defence of his views concerning the nature of ozone and nitric acid, and begs in conclusion for a letter from Berzelius stating that he (Schönbein) was the first discoverer of gun-cotton. He had patented this explosive in England, and says that his patent "will undoubtedly be contested."

Berzelius died August 7, 1848, and the editor has discovered a short sketch of an obituary notice by Schönbein which was apparently never published, but which had been hastily written on a sheet of paper partly covered by the draft of a letter to Faraday. The position occupied in the world of science by the illustrious Swede needs no further definition at the present day, but this short estimate of his achievements by his contemporary Schönbein will still be read with interest.

We have once again to express our obligations to Dr. Kahlbaum and his colleagues for a remarkably interesting little contribution to the history of chemistry.

R. MELDOLA.

SOME OBSERVATIONS ON ANIMAL HYPNOTISM.

Beiträge zur Physiologie des Centralnervensystems. Von Max Verworn, a.o. Professor an der Universität Jena. Erster Theil. Die sogenannte Hypnose der Thiere. Pp. iv + 92; and 18 figures. (Jena: J. Fischer, 1898.)

THIS volume by Prof. Verworn, on the phenomenon of so-called hypnotism in the lower animals, is a clear and exhaustive account of the subject. Paucity

of knowledge renders the theme one very limited for scientific treatment. During the past two and a half centuries, various inquirers into nature, from Daniel Schwenter and the Jesuit Father Kircher onwards, noted that by handling animals it is possible to impose upon them postures. Though strained, these are for a time maintained after release from the hands of the "operator." This "animal plasticity" recalls the plasticity of the human subject in the cataleptic phase of hypnosis. In human hypnosis, however, the cataleptic rigidity is only one, and not the most striking, of a set of concurrent symptoms contributing to make up the hypnotic state. Abeyance of will, ultra-sensitivity of the senses, contraction of the field of attention with substitution of passivity for activity, appropriate response to complex sensorial stimuli of the organs of vision and hearing, execution of acts resembling those of volition, paralysis of memory, all these characters of hypnotism predicate a mental organisation much higher than can be attributed to the majority of creatures in which the so-called "animal hypnotism" can be induced. These remain, therefore, almost without counterpart in "animal hypnotism." If it is permissible to speak of "will" in dealing with neural types so far removed from human as those of the crayfish and the amphibian, there does occur in animal hypnotism what resembles suspension of "willed" action. The animal remains motionless for long periods in postures which it has been constrained to assume. The guinea-pig is, as regards neural organisation, the highest type in which the phenomenon has been at all systematically studied. Both cat and dog are reported "refractory." It is true a condition characterised by cataleptoid plasticity has been observed in the monkey subsequent to extirpation of its cerebral hemispheres. The animal then enters a peculiar state known as "decerebrate rigidity," of which a spastic contraction of the extensor muscles of the limbs and trunk is characteristic. That this condition in the monkey is allied to that termed "animal hypnotism" is strongly suggested by the fact that, as Heubel first showed, the induction of so-called hypnotism in the lower types is favoured by decerebration, and the plasticity is more pronounced in decerebrate than in intact animals.

Prof. Verworn has succeeded in obtaining graphic records of the contraction of the implicated muscles during their condition of tonic rigidity. He notes that the constrained postures in which the rigid animal remains are all of them attitudes assumed in attempt at recovery of the normal from an abnormal posture, *e.g.* in attempt to right itself after being placed over on its back. When the creature breaks from the spell its escape is usually sudden. Those muscles, then, that have been in tonic contraction do not relax, but by contracting further complete the execution of the movement toward which the posture was an approach.

The long continuance of the hypnotic tonic contraction leads Prof. Verworn to conclude that there must, during its course, become established in the nerve-cells and muscle-cells an equilibrium between assimilation and dissimilation. This instance induces him to sketch the theory of the chemical exchanges involved in cell-life. The cell must, as a chemical machine, be able to live and work at various rates all equally without exhaustion. A faster rate of liberation of energy by decomposition of the molecules is met by faster replenishment of energy by the synthesis of new molecules. The author speaks of the functional activity of the cell in relation to its metabolism as "biotonus," *e.g.* the biotonus of the nerve-cell. The Jena school of physiology is so closely associated with the teaching of the elder Hering, to whom we owe the theory of assimilation and dissimilation as colligate functions of protoplasm, that no doubt the sketch given by Verworn is not intended to challenge comparison with Hering's essays. It is probably intended to fall into place as an item toward the general promulgation of Hering's fundamental doctrine; this it does, though the exact application of the theory to the as yet insufficiently analysed phenomenon of animal hypnotism is not so definite as that of some other examples that could more easily have been found.

The volume is altogether an interesting one. It is considerably enhanced in value by thirteen excellent figure photographs from nature of animals in the condition of the so-called "hypnosis." C. S. S.

OUR BOOK SHELF.

Memoranda of the Origin, Plan and Results of the Experiments conducted at Rothamsted; Fifty-seventh Year of the Experiments, 1900. (Issued by the Committee.)

THE history of this publication is worth noting. It first appeared in 1855, the year of the opening of the new laboratory at Rothamsted, and was issued for the use of the numerous visitors to the experiments; it then consisted of four pages, giving the last year's produce on some of the experimental fields, and the scheme of cropping and manuring of the other fields on the farm. The next issue was in 1862, when the average produce on each plot was given. For some years it was not published annually, but supplements were from time to time issued. Annual publication commenced in 1872. In 1878, a preface giving an account of the origin and scope of the Rothamsted experiments was added, with a list of the papers already published. But little alteration in its character has since taken place, though the additions have been considerable. The present volume contains 120 pages, and supplies plans of the experimental fields.

The "Memoranda" do not furnish a report of the work done at Rothamsted by Messrs. Lawes and Gilbert, except so far as this is shown by the preface reprinted each year, and the lists of papers. The pages are mostly occupied by a mass of figures, showing the manuring, and the average produce on each experimental plot with the produce of the last year. There are also tables giving some particulars of the chemical composition of the sugar beet, mangel wurzel, and potatoes grown by various manures. There is little or no discussion of the numerical results recorded, but most of the sections begin with some remarks elucidating the general character of the experiment next described.

As the produce yielded by nearly every experimental plot is annually published in these "Memoranda," the record is one of great value to the student, especially if he has at his disposal a complete series of the earlier issues. When thus furnished he is able to study the results of the experiments in a very thorough way, having a complete up-to-date record to work on. Unfortunately, however, this is just the kind of publication which is seldom saved and bound for reference, and it is doubtful if many complete sets now exist.

The tables of the "Memoranda" are little suited for the use of the popular writer, and sad mistakes are

sometimes made by the agricultural press in their quotations from them. This is generally due to the alterations in the manures on some of the plots during the long course of the experiments, the average produce of the plot given in the table thus sometimes bears no relation to the manure which the plot is now receiving. In the summary tables now separately printed for the use of visitors to the fields these errors are avoided by calculating the average produce for those periods only to which the present manuring applies.

A melancholy interest attaches to the present issue of the "Memoranda" as being the last with which Sir J. B. Lawes, the founder of experiments, will be personally connected. R. W.

The Scenery and Geology of the Peak of Derbyshire. By Elizabeth Dale. Pp. viii + 176. (Buxton: C. F. Wardley. London: Sampson Low and Co., Ltd., 1900.)

THE main object of the author, who is Pfeiffer student of Girton College, Cambridge, "has been to give a simple account of the geology of this most interesting district, treating this limited subject in such a way as will make it possible for the book to serve as an introduction to the study of the science." That this purpose has been carried out in a thorough and praiseworthy manner will not be questioned. Miss Dale is well acquainted with the district; she has herself contributed to our stock of knowledge, and has gathered other information from the best authorities. The country of the Peak is attractive to lovers of scenery as well as geological students; and a handy volume which tells as this does of the numerous fine sections, of good localities for fossils, of the origin of the physical features and of the caverns and their varied contents, is sure to be appreciated. We doubt, however, the wisdom of introducing so much general geology in what is essentially a local guide. It would have been enough to point out the lessons to be derived from the rocks in the district without dealing with other matters, such as the nebular theory, or the growth of geology and its relation to modern thought. Those who reside in Derbyshire, and have no other geological books, may be glad to have such full information; but those who want only the local facts, and explanations of them, will not be so pleased. The work throughout bears evidence of painstaking research, and we notice very few errata. The book has a somewhat provincial aspect in its "get up;" some groups of illustrations, when they occupy a whole page in the text, are notified as plates, while, curiously enough, Plate vii. is placed before Plate vi. There is a well-printed and clear geological map of Buxton and neighbourhood; but it ends off in the middle of Kinderscout, which is marked on the map as "The Peak." The pictorial illustrations are fairly good; they would have been excellent if well printed.

Malaria. By Angelo Celli, Director of the Institute of Hygiene, University of Rome. Translated by John Joseph Eyre, with an introduction by Dr. Patrick Manson. Pp. xxiv + 275. (London: Longmans and Co., 1900.)

SINCE Laveran's great discovery of its parasitic nature, war has been waged with ever-increasing vigour against malaria, and Italy has always been in the forefront of the battle.

The fortunate combination of an ample supply of material and men capable of taking advantage of it has resulted in great and important additions being made to our knowledge of the fever and its etiology.

Among the Italian workers Prof. Celli is one of the most prominent, and the present volume, founded on a recent course of lectures delivered in Rome, gives us a cursory glance at much of the work on which his eminence is based.

By dealing, as he does here, only with the malaria fevers of the Roman Campagna, Prof. Celli loses nothing in interest, for though we agree with him when he says malaria is a local phenomenon which must be studied on the spot, and data gathered in a particular territory cannot be generalised, yet a book that will enable English readers to readily acquire a succinct and fairly complete knowledge of the recent progress towards the elucidation of the malaria mystery cannot fail to be gladly welcomed.

The lectures contain necessarily much that is true without being new, and the information, though sound on the whole, is on some points rather scanty. This is specially true of the description given of the various mosquitoes responsible for Roman malaria; the information on this point is slender and quite inadequate for the identification of species. The bionomics of the mosquitoes are also insufficiently detailed, and several important points are omitted. No mention is made of the peculiar attitude assumed by Anopheles when at rest, nor is the tendency of Culex to lay their eggs in artificial receptacles of water noticed.

It is, moreover, inaccurate to say that mosquitoes live only in low-lying places. In British Central Africa they have been found at an altitude of several thousand feet.

One of the best parts of the book is that which deals with the local or physical causes of predisposition or of immunity, and it will be seen how remarkably it agrees with the accounts of similar observations in other parts of the world. Readers who are aware of the efforts now being made to improve the conditions of European life in the tropics will appreciate the emphasis with which this part of the subject is treated.

Part ii. deals with Prophylaxis in its various aspects, and here the author is at his best. The advice he gives is excellent and practical, and if intelligently followed would greatly reduce the ravages of malaria. No mention is, however, made of either mosquito curtains or punkahs. It is satisfactory that justice is done to Ross's epoch-making work, an example which might well be followed by some other Italian writers.

The nomenclature differs somewhat from that now generally adopted in England; hæmosporidia being substituted for hæmamœbidæ, and sporozoites for blasts.

The translator has done his work well, though his choice of words is not always good. The illustrations are good throughout, but we think it a mistake to represent the mature zygote in Fig. 19 as possessing a double-walled capsule, and the unstained blasts on the same plate are not correctly depicted.

A Year with Nature. By W. P. Westell. Pp. xvi + 276. Illustrated. 8vo. (London: H. J. Deane, 1900.)

WITH every desire to be charitable to an author who, so far as we are aware, has seen his work "within covers" for the first time during the present year, we are fain to confess ourselves at a loss to conjecture the class of readers for whom the volume before us is intended. Clearly it is not for the professional naturalist; and we doubt whether the average reader interested in natural history will find much entertainment in its pages.

Apparently the general plan of the work is intended to be a kind of naturalists' calendar, but intercalated in several of the chapters are essays on subjects which seem to have no connection with the one in hand. We fail, for instance, to see any connection between birds' tails and October, or between their beaks and September; neither do we realise the affinity between January and Mr. Rothschild's museum at Tring Park—certainly none such could have been suggested by the author's reception when he visited that admirable institution.

In his preface the author very candidly, although perhaps somewhat superfluously, informs his readers that he has "not tried to cultivate any literary style or artistic merit." He might have added that his mode of

framing a sentence is such as, at times, to convey to his readers a meaning totally different from the one he intended, and also that he is not always acquainted with the signification of the terms he employs. As an example of the former kind of error we may refer our readers to p. 17, where it is stated that antelopes and snow-leopards are "denizens of the deep"; while as a sample of the second we may adduce the misapplication of the term "antlers" to the cranial appendages of sheep (p. 26).

Admitting that Mr. Westell displays a strong love of nature, the best we can say of the text in general is that, for the most part, it consists of descriptions of what may be seen during a country walk at different seasons of the year, interspersed with platitudes and reflections, and extracts from poems. We have, however, failed to detect anything strikingly original either in the proper subject of the book or in the articles devoted to the discussion of the beaks, tails and feet of birds. The article on the Rothschild museum and menagerie seems chiefly intended to display the author's profound ignorance of natural history in general.

The one redeeming feature of the book is to be found in the illustrations, which are exquisite examples of photogravure; and if it consisted of these alone (which, by the way, have been photographed by friends of the author), it would certainly form a pretty picture-book for the drawing-room table. But, as the author is once again candid enough to admit, the illustrations, for the most part, have no sort of connection with the text, and are, so to speak, thrown in at haphazard.

A few of the articles, it seems, have previously appeared in magazines; while the majority or all of the rest were first published in the columns of certain local newspapers circulating in the home counties. In our own opinion, the author would have been better advised had he been content with the credit to be derived from such ephemeral publication. R. L.

The Geology of Sydney and the Blue Mountains: a Popular Introduction to the Study of Geology. By the Rev. J. Milne Curran. Second edition. Pp. 391. (Sydney: Angus and Robertson, 1899. London: Australian Book Co., 38, West Smithfield.)

THIS is, strictly speaking, an elementary manual of geology, written and illustrated with especial reference to the geology of Sydney. The general plan of the work is good; the book is well printed and illustrated with maps, photographic pictures of rock structure and scenery, figures of fossils and rock sections; and it is satisfactory to learn that the labours of the author have been appreciated, as the first edition, published in 1898, was sold out in a few months. This speaks well for the interest taken in the study of geology in New South Wales. The colony is fortunate in having representatives of all the great geological systems from the Silurian upwards, but it is sufficient for the Australian student to learn the forms of life which characterise these main divisions all the world over, while he supplements the knowledge with particulars of the strata and organic remains in his own country. To him information about the Hawkesbury-Wianamatta series or the Mount Lambie sandstones is more important than a description of the Wenlock Limestone, the Lower Greensand or the London Clay.

The author gives general accounts of fossils, minerals, and rocks, but he sometimes becomes too popular in style, as, for instance, when he remarks of the Labyrinthodon, that "This ungainly creature was a shovel-headed Salamander, which pottered about like Falstaff in his old age, 'with much belly and little legs.'" To be very popular and also exact is difficult, and in this respect the author is not wholly successful.

Information is tabulated and repeated almost to excess; there is a table of the stratified rocks of New South Wales, another of the principal Australian sedimentary formations, and a third of the general succession of Australasian strata, to say nothing of minor tables. The characteristic fossils of the Australian formations are enumerated (pp. 84, 85), but in so erratic a fashion that saurians, fishes, echinoderms and mollusca are hopelessly mixed.

The author observes in his preface (p. 8) that "some friendly critics have found fault with the disposition of the illustrations." These critics were quite right. There is no excuse for placing a figure of the Triassic *Trematotus* in a page dealing with Pleistocene, nor a figure of remarkable weathering of sandstone in a page treating of basalt!

The sketch map which serves as frontispiece has no scale attached to it, while the coloured geological map of Mount Victoria, Blackheath and Hartley takes in a part of the Blue Mountains, though the fact is not made manifest. It is desirable that references be given in all cases where quotations on scientific subjects are made, and it would be well to add the initials of authors in the list of works given in the appendix.

The author concludes his work with a glossary. We doubt the utility of giving the derivations of many biological names; some of these appear ludicrous, as, for instance, *Agnostus* (I know not), *Athyris* (without a door), *Avicula* (a little bird), *Phanerogams* (visible marriage), &c. These, however, are trifling matters. The book is one on which further pains may advantageously be bestowed, as it is sure soon to reach a third edition.

Light Railways at Home and Abroad. By. W. H. Cole, M.I.C.E. Pp. x + 339. (London: C. Griffin and Co., Ltd., 1899.)

WHILE it is too soon to say that the Light Railways Act of 1896 has in any degree failed in its object, it must be admitted that as yet there are no signs of that revolution in the transport service of country districts for which the more enthusiastic promoters of the Act had hoped. Of the many schemes that have been brought forward but few have emerged from the successive ordeals of the Light Railway Commissioners and the Board of Trade, and of these several have failed to secure the necessary support of capital. This is hardly to be wondered at, for the districts in which the need of improved facilities for transport is most urgent are precisely those in which the spirit of enterprise and the power of raising capital are weakest. The British agriculturist, too, whether landlord or tenant, has been so long unaccustomed to take joint action for a common end, that many hopeful schemes have failed to obtain the support of those who might be expected to reap the chief benefit from them. It may be that the provisions of the Act require modification, that the Board of Trade must become less exacting in its conditions, that greater encouragement must be given to local authorities, or easier access afforded to Treasury grants. These are questions which a few years working of the Act will answer.

Meantime, to all who are interested in the subject of light railways, whether as promoter, engineer, or possible user, Mr. Cole's book is indispensable. His object has been to collect all available information from many scattered sources, and to condense and present it in compact and accessible form, and he has succeeded in producing a very useful book of reference. Something more than a hundred pages are devoted to light railways abroad, special attention being given to their development in Belgium, France, Italy and India. In each case full details are given as to the provision of capital, whether by the State, by local authorities or by private enterprise; as to gauge, weight of rolling stock, use of highways and other details of construction; as to various economies of working, limits of speed and precautions

for safety; and, lastly, as to the financial return and the disposal of profits when such exist.

The second portion of the book is more directly concerned with light railway development in England. A useful chapter is concerned with an analysis of the Act of 1896, while the special chapters on "The Question of Gauge" and on "The Construction and Working of Light Railways" are perhaps the most valuable in the book. On the question of gauge it may be worth while to quote Mr. Cole's conclusion, which is that for railways making connection with main lines the standard gauge is imperative, and that for smaller independent lines the reduced gauge of thirty inches may be used. In this connection we notice no reference to the Duke of Westminster's narrow-gauge railway at Eaton Hall, though this is, perhaps, the most instructive example of a small and self-contained railway in the United Kingdom.

The book contains a number of folding plates, showing details of construction both of permanent way and of rolling stock; and a long appendix includes tables of returns for many railways, both of standard and of light construction, as well as the full text of the Act of 1896 and its schedules.

Les Plaques sensibles au Champ électrostatique. Par V. Schaffers, S.J. Pp. xxxix + 19. (Paris: A. Hermann, Librairie Scientifique, 1900.)

THE phenomena treated of in this pamphlet are those observed when an electric discharge from a powerful Whimshurst was passed over the film of a photographic plate between two metallic points which usually were both in contact with the film. A great variety of films, containing various metallic salts mixed with different emulsions, &c., besides those ordinarily used for photographic purposes, were tried.

The potential difference used was not enough to spark across between the poles, and the changes produced in the films are probably mainly due to the current through the film, and not to the discharges through the air above it. In some cases the marks produced on the plate were approximately parallel to the lines of electrostatic force or current stream lines through the film, and several plates are given showing the effects obtained in such cases. A considerable variety of peculiar and more or less interesting appearances are clearly described, and possible explanations of them discussed. Scarcely any variations in the method of submitting the material to the action of the discharge were tried, and the object of the experimenter seems to have been more to obtain a large variety of peculiar appearances than to really elucidate the nature of the actions taking place. The method of obtaining pictures of the lines of force or current stream lines between conductors on the plates is described in detail, and such pictures as the author points out may be useful for educational purposes in some cases.

H. A. W.

The Elements of Plane Trigonometry. By Prof. W. P. Durfee. Pp. vi+105. (Boston, U.S.A.: Ginn & Co., 1900.)

THERE are a few novel points in this book. Logarithms and their use in computations are dealt with in the first chapter, and most of the exercises are of a character which will lead the student to see that trigonometry has a practical value. The second chapter deals with trigonometrical ratios, and is followed by chapters on unlimited angles, reduction formulæ, the addition theorem, relations between the sides of a triangle and the trigonometrical functions of its angles, and solution of triangles. Logarithms are used in all the calculations. The course of work in the book is suitable for elementary students of trigonometry, and constitutes an introduction to the theory of functions as illustrated by trigonometrical ratios.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Autotomic Curves.

MR. RICHMOND's letter appears to be written under a misapprehension. My objection to such phrases as "non-singular cubic curve," "non-singular curve of the *n*th order," arises from the fact that a point of inflexion is just as much a singularity as a node, and that it is therefore inaccurate and misleading to describe such curves as non-singular. In fact, the only non-singular curves which exist are conic sections; all others are singular. On the other hand, the word autotomic exactly expresses the idea it is desired to convey; and I have been informed by several excellent Greek scholars that they do not consider the phrase "an anautotomic curve" open to objection, and that the alliteration may be frequently avoided by the use of the words every or any instead of an.

The terms *sesecting* and *non-sesecting* appear to be unobjectionable from a literary point of view; but with regard to *unautotomic* and *nodeless* there is a general consensus of opinion amongst writers who are careful about their style against the use of hybrid terms composed of words belonging to two different languages.

A. B. BASSET.

Fledborough Hall, Holyport, Berks, November 16.

A Remarkable Dolphin.

DR. WAY, the headmaster of Rossall School, has recently forwarded to the Natural History Museum (for determination) portions of a cetacean stranded at Rossall in September. These portions include the skull, the imperfect flippers, the tail (including the caudal vertebræ), and the back-fin.

The skull and other bones leave no doubt that the animal is the bottle-nosed dolphin (*Tursiops tursio*). In place, however, of the ordinary "flukes" of a dolphin, the tail terminates in two long, narrow lobes, of which one is very much longer than the other; and, were it not placed in a horizontal instead of a vertical plane, it might well be mistaken for the tail of a thresher shark. The larger lobe of the tail measures 5 feet 3 inches, while the total length of the remainder of the creature was 10 feet. A similar abnormal elongation is noticeable in the case of the back-fin, which is about twice as long as ordinary, and proportionately slender. Externally, both the tail and the back-fin are thickly coated with small sea-weeds and sertularians.

Judging from the teeth, the animal appears to be very aged, and the only conjecture I can make in regard to the tail and back-fin is that their abnormal form is due to pathological hypertrophy, perhaps induced by an injury. I should be glad to hear of any other instances of analogous malformation among cetaceans.

R. LYDEKKER.

British Museum (Natural History), Nov. 19.

The Optics of Acuteness of Sight.

OBSERVATIONS have been frequently made upon the remarkable eyesight of certain uncivilised tribes. Travellers have told us of guides who could see four of Jupiter's satellites with the unaided eye; and lately Sir Redvers Buller has declared that the average Boer can see at least two miles further than the British soldier. It is of some interest to consider whether this superiority is due to a real change in the optical properties of the eye, or merely to some special ability to interpret slight differences of impression, which might be acquired by practice. As we have as yet no data as to the constants of a Boer's eye, we may raise the question whether such feats are optically impossible for an Englishman's eye.

The minimum visual angle is determined by the transverse diameter (c) of a foveal retinal cone, and its distance (F″K″) from the second nodal point of the eye. We have—

$$\tan\frac{\alpha}{2} = \frac{\frac{1}{2}c}{F''K''}$$

and, where $c = \cdot 002$ mm., $F'K'' = 15\cdot 498$ mm.

$$\alpha = 26\cdot 618''$$

In order that two points may be distinguished as such by the

eye, their retinal images must be separated by at least one unexcited retinal cone. The distance between the two images must therefore be ·004 mm., or the intervening cone may be encroached upon. Therefore the minimum visual angle

$$\theta = 2a = 53 \cdot 236''.$$

Now Jupiter's edge and his first satellite may subtend at the sun an angle of 1·33″, so that we may regard this as the average angle subtended at the earth. Hence we see that there is no optical reason why the four satellites should not be seen by the naked eye. If they were sufficiently bright they no doubt could be distinguished by the normal Englishman's eye. "It must be remembered, however," as Sir Michael Foster says, "that the fusion or distinction of sensations is ultimately determined by the brain. The retinal area must be carefully distinguished from the sensational unit, for the sensation is a process whose arena stretches from the retina to certain parts of the brain, and the circumscription of the sensational unit, though it must begin as a retinal area, must also be continued as a cerebral area, the latter corresponding to, and being, as it were, the projection of the former." No amount of education can make the sensational unit smaller than the minimum retinal area, though by practice the cerebral area may be made more sensitive to minute sensational impulses.

A. S. PERCIVAL.

26 Ellison Place, Newcastle-upon-Tyne.

ELECTRIC TRACTION TROUBLES.

THE English—the pioneers in the development of railways, steamships, the telegraph, and other inventions of the nineteenth century—are now running the risk of becoming a nation of imitators. Apart from the fact that the entire route, Shepherd's Bush to the Bank, was not sent bodily across the Atlantic to be tunnelled, the Central London Railway might almost as well have been constructed in Central America as in Central London.

For not merely did the steam-engines come from Milwaukee, the electric lifts from New York, the dynamos, locomotives, and other electric apparatus from Schenectady, but the curious practice of requiring a passenger to first purchase a ticket and then drop it immediately into a box, as well as the projection of information into each end of a car on quitting each station are Yankee notions, and one expects to hear that the "next station is Chippawa" or Winettea, and not commonplace Bond Street or Oxford Circus.

The characteristics of American traction are convenience, comfort, speed, low fares and a liberal scattering of the electric current over the district generally. Chinese like, we have faithfully adopted them all. To go from the City to the Albert Hall, up to this summer, one went, of course, from the Mansion House to the South Kensington railway stations. Now one saves time and money by being whisked electrically to Lancaster Gate and walking across Kensington Gardens. No wonder, then, on C.I.V. Monday 230,000 people used the Central London Railway, enough passengers, in fact, to fill every seat one and a quarter times in every train from early morn on Monday to the small hours of the following day.

No need to issue return tickets at reduced rates when every passenger who goes by this line can be relied upon to return by it. What matters it, then—may think the artisan, the clerk, the stockbroker, the investor, and even, perhaps, the engineers and directors of the Central London Railway itself—by what route the electric current returns? The electric current that starts from the Marble Arch, say, must, from the nature of things, go back there. Why, then, should advantages be offered it that are not thought necessary in the case of the general public to induce a return home inside the tube?

If one were a shareholder *only* of the Central London Railway, one might find it difficult to realise that any other interest was of any consequence. But, if a considerable portion of one's income happens to be derived from dividends on the shares in gas and water companies, one may prefer that these sources of income shall not be seriously interfered with. Hence, the clean white glazed brick walls, the brilliant arc lamps, the pleasant gliding lifts, the entire absence of those rolling clouds of smoky steam that greet a passenger as he descends into the Euston Road on a damp, cold November day, fail to cheer him on his swift modern progress under Oxford Street, should he make the following little elementary calculations:—Over 2000 electric horse-power which, at times, every day is already actually put into the Central London Railway at a single sub-station between Shepherd's Bush and the Bank means a current of over 3000 amperes; and this current, after passing through the electro-motors on the trains in the neighbourhood of that sub-station, has to come back there through the *uninsulated* rails on which the trains run. Suppose, in consequence of these rails being *un*insulated, 10 per cent. of this return current strays outside the iron tube and comes back by the iron gas and water pipes running parallel with the railway on the ground above it. This means about $\frac{3}{4}$lb. of iron removed from the gas and water pipes in an hour in the neighbourhood of a sub-station.

Such large currents, however, as 3000 amperes are at present probably only seldom reached, therefore, to avoid even an approach to exaggeration, let us assume that the average current which strays into the gas and water pipes on its way back to a sub-station is only, say, $\frac{1}{100}$th of the maximum value of the current leaving a sub-station each day. This seems a modest enough estimate. Then, since the line works some eighteen or more hours per day, this means about *a quarter of a ton of iron* removed per year from the gas and water pipes in the neighbourhood of *each* of the places at which the current is fed into the railway. Consequently, as there are several such places between Shepherd's Bush and the Bank, this would lead to more than *one ton of iron* being eaten out of the pipes each year.

Is this important? Well, as holders of gas and water companies shares we should say, very! But are the travelling facilities of the London public to be interfered with, is the development of electric traction to be hampered—just when our people are having their first taste of the immense advantages that accrue from propelling trains and tramcars by electricity—simply because several millions sterling happen to have been invested on pipes, retorts, gasometers, waterworks, &c., and because there are people so blind as to actually prefer the receipts of regular dividends to the slavish copy of American practice?

Luckily, no such terrible alternative need be flourished in the faces of our democratic governing bodies, who, while naturally anxious to defend the people from the supposed extortions of the gas and water companies, are no less anxious to shield from the incursions of the electric traction capitalist a large class of persons with small incomes who have placed their savings in what they rightly regarded as safe investments—viz., the shares of gas companies.

Another electric service has been inaugurated this year in which trains as large as, or larger than, those on the Central London Railway are driven electrically over a far more difficult route—viz., from Earl's Court to High Street, Kensington, among ordinary trains over points and crossings.

And yet, in spite of this greater difficulty, there is not merely an insulated conductor to take the electric current to the trains, as on the Central London Railway, but also an insulated conductor to bring it back by; and the rails on which the electric trains run between Earl's Court and High Street, Kensington, are used simply for

what they were originally put there—viz., to carry the weight of the train, and not to ineffectually carry an electric current also. Such a system enormously diminishes the electrolytic corrosion of gas and water pipes; and, since it is a system that has been designed by a celebrated firm of consulting electrical engineers and carried out by a no less celebrated firm of electrical contractors, surely nobody suggests that it is in any sense impracticable.

It will be urged, however, that on that vast network of tramways lying between Uxbridge Road and Acton, Hammersmith and Hounslow, Kew and Richmond, &c., which will shortly be worked electrically, two overhead insulated conductors are impossible, and we must adopt the American system. Yes, but what American system? The conduit system, for example, employed already for years in Washington, and of which some seventy miles now exist in New York, in which there are no overhead wires at all, but an insulated going and an insulated return conductor, both under the street? Or is all this too modern for England, and can we not project ourselves in advance of where America was several years ago, and must we resort to the old insulated trolley wire to take the current and the *un*insulated rails to bring it back?

Why, only recently there was suggested, in one of the technical papers, a proposal to overcome all this difficulty in the case of street electric tramways by taking the current to the cars by means of an overhead trolley wire as hitherto, but using instead of the rails as the return conductor an *insulated* cable which was connected automatically with a car as it passed along and which, differing in potential from the earth by only a few volts, could not give rise to appreciable leakage to the ground. Will an insuperable barrier to a trial of such an English system be found in the fact that its parent, called "surface contact," was itself born of English parents in 1881? Must it, like an opera singer of forty years ago, first adopt an Italian name before it will be accepted by a British public?

Already the Central London Railway Co. has given notice of an application to Parliament for powers to extend westward and eastward; every week now some new underground electric railway scheme blossoms forth for London, while in a few years electric tramways will doubtless be a common method of conveyance in this city. An urgent question, therefore, that London must ask itself *to-day* is—Does it want to preserve its gas and water pipes?

AGRICULTURAL DEMONSTRATION AND EXPERIMENT.

THE issue by the Board of Agriculture of the "Annual Report on the Distribution of Grants for Agricultural Education and Research in the year 1899–1900," directs attention to a department of educational activity which was practically non-existent in the beginning of the present decade. From this it need not be inferred that there was no education in agriculture—both in the class-room and on the field—before this date. The work of Rothamsted, of our leading agricultural societies, and of certain agricultural colleges, is conclusive evidence to the contrary. But it was not till some ten years ago that the aid of the State was given to the establishment and maintenance of agricultural departments in provincial colleges, and of independent teaching institutions, which should be in a position to supply education and advice to the agricultural community in their district.

The report before us summarises the courses of instruction, attendance, intra- and extra-mural work, and financial aspects of each of the eleven English and Welsh collegiate departments and teaching institutions that divide amongst them 7750*l.* of the Board's grants. The grants to Scotland have, since 1896, been paid through the Scotch Education Office, so that the work of North Britain does not come within the purview of the Board's report.

Within certain limits, each institution is allowed to administer its grant and organise its work on the lines that experience has shown to be most consistent with local requirements. As a result, we find considerable variety in the educational ramifications of the different centres, though this variety is less pronounced now than formerly. Practically all the colleges receiving the Board's grants have arranged courses of instruction, extending over two or three years, which lead up to a certificate, diploma or degree. In addition to these extended courses, most of the colleges are now holding short courses of six to ten weeks, which are specially designed to meet the wants of young farmers who cannot be spared from home for a longer period. Such classes have proved most useful in America and on the Continent, and they are also being well attended in this country.

A prominent feature of the work of all the colleges is the conduct of field demonstrations and experiments, of which a condensed account is given in the second section of the appendix of the Report under notice. This form of educational work was vigorously prosecuted by Young and Marshall in the latter half of last century, and, in the face of a mild undercurrent of opposition, it has been continued ever since. It is a form of educational activity that has been largely developed in the United States, in Canada and on the Continent, so that it may fairly be urged that, whatever its weaknesses, it has, on the whole, gained extensive adoption by reason of intrinsic merit. The objectors to this form of education, or means of agricultural improvement, base their opposition on the following grounds:—

(1) The difficulty of getting a series of plots on soil of equal quality.

(2) The danger of applying results obtained on one farm to the agricultural practice of another.

(3) The possible interference with results of extraneous causes, *e.g.*, birds, mammals, insects, diseases, weather.

(4) The misinterpretation of the value of purely quantitative results.

No doubt the usefulness of field trials may be marred, or worse, by failure under these heads, but the exercise of ordinary care in selecting the land, the rejection of results that have manifestly been unduly influenced by extraneous causes, and, above all, the frequent repetition, both as regards place and season, of the experiments, must in the end furnish a set of figures that cannot fail to prove a useful guide in agricultural practice. If one may not indulge in wide generalisation from even a considerable number of concrete cases, that is no valid argument against field trials. On the contrary, it is fair to say that if there are a large number of soils that require special treatment, it is the more necessary that farmers should be made familiar with the arrangements and method of field trials, in order that they may, by their aid, inquire into the manurial and other requirements of their own land. In point of fact it is probable that therein lies the main value of such work. No one, who has given careful heed to the experimental results of past years, will deny that, at least under certain conditions of soil, some very striking and unexpected results have been obtained. Farmers who see such results, recognise that they have made the acquaintance of facts that they would not have anticipated, and they naturally conclude, and rightly, that if the unexpected has

happened on the farm of a neighbour, it may be that their own practice is not all that could be desired. When once this spirit of inquiry has been roused, a long step forward has been made. But farmers will give attention to work that is going on in their own neighbourhood, under conditions with which they are familiar, when they would not concern themselves with results obtained on a station that they had never seen. For this reason, local experiments and demonstrations would be justified, even if they were no more than a repetition of work conducted elsewhere.

Some curious results have, from time to time, been got with potash, and at no place has this been more conspicuously the case than at the Northumberland Demonstration Farm of Cockle Park. Speaking generally, and taking the average of several seasons, one finds that, in the North of England, the addition of 3 or 4 cwt. of kainit per acre to a nitrogenous-phosphatic artificial dressing increases the turnip or swede crop by about 30 cwt. per acre. Such a return is moderately profitable, but not sufficiently so to make it a matter of the first importance, whether north-country farmers use potash for their turnips or not. But not so at Cockle Park, where the arable land is a light loam overlying millstone grit. At that station, potash has proved to be absolutely indispensable in the growth of root crops, so much so, in fact, that, without the support of potash, other manurial elements have practically no effect. The figures for turnips—in terms of an acre—for three years are as follows:—

Treatment of crop.	1896		1897		1898	
	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
Unmanured	19	19	2	10	13	2
Nitrogen and phosphoric acid, no potash	16	17	4	17	8	3
Nitrogen and phosphoric acid, with potash	26	3	14	10	25	5

During two of the seasons the crop was actually injured by the use of nitrogen (in the form of sulphate of ammonia) and phosphoric acid (in the form of superphosphate of lime) unsupported by potash. Similar results have been got by at least one foreign investigator by means of water-cultures, and it would be interesting to have an explanation of this curious phenomenon. But, without any explanation, the many hundreds of farmers who have seen these demonstrations have at once perceived that, on land of this character, large expenditure on manures may be absolutely profitless; and they have gone home with the determination to experiment on their own land, in order to ascertain whether their system of manuring is as rational as it might be.

To show how unsafe it is to apply, generally, results obtained with one class of plant, attention may be directed to some experiments begun in 1897 on a permanent meadow, situated within a few hundred yards of the three fields in which the turnip experiments were conducted. The soil of this meadow is somewhat more argillaceous than that of the arable land, but from the appearance of the soil, and in view of the results referred to above, one would not expect that the herbage growing upon it would be absolutely independent of artificial supplies of potash. And yet four years' results have shown that not only does potash fail to increase the yield, but that, when used unsupported by phosphate, it does positive harm. The figures are as follows, the sulphate of potash, which was applied each year, supplying 50 lbs. of potash per acre:—

Treatment.	1897	1898	1899	1900	Total
	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Unmanured	22½	27½	19½	20	89½
Potash only	20	25½	13¾	16¾	76
Sulphate of ammonia	33½	37¼	25	26½	122¼
,, ,, plus potash	29¾	35¼	19	22¾	106¾
Phosphate	25	32¼	23¼	27	107½
,, plus potash	26¼	36¼	20½	26½	109½
Ammonia and phosphate	35¼	41½	26¼	30½	133½
,, ,, plus potash	33½	41	24¼	30½	129¼

Without any exception, the potash has invariably reduced the yield (*a*) when used alone, and (*b*) when added to a nitrogenous manure. This depressing influence is more pronounced in the last two than in the first two years, a result doubtless due to the accumulation of potash in the soil. When used along with phosphate, the potash slightly increased the yield in the first two years, whereas it has reduced it in the last two. Finally, when added to both nitrogen and phosphate, the action of the potash has either been harmful, or, at the best, negative.

These results not only come out in weighing the crops, but they are precisely what one would anticipate from the general appearance of the plants. In the case of turnips, the plants that have received no potash are of an unhealthy green colour. The leaves are shrivelled and puckered, and covered by large yellow blotches. In the case of the meadow plots that have received potash, *without phosphates*, the herbage is pale, almost brownish-green in colour. In other parts of the country this poisonous influence of potash on the mixed herbage of meadows has been observed, Mr. Wood, for instance, having recorded several cases in the east of England. It is evidently a subject of some scientific interest, and worthy of further investigation.

In the past, the agricultural experiments and demonstrations conducted by the local colleges and other institutions subsidised by the Board of Agriculture have been chiefly concerned with the manuring of land, though a considerable amount of work has, in the aggregate, been done in the direction of (*a*) testing new varieties of plants; (*b*) dealing with insect and fungoid injuries, and the eradication of weeds, notably charlock; (*c*) the rearing and feeding of stock; (*d*) dairying; (*e*) cider manufacture. The initiation of such work has, with few exceptions, been left entirely in the hands of the staff at the various centres, and while much is to be said in favour of this system, there is a good deal to be urged against it. More particularly it is apparent that the lack of any central control, or, it may be, the want of opportunities for consultation among the workers, has engendered a certain amount of unnecessary confusion, which could easily have been avoided with advantage to every one. While one worker uses 50 lbs. of phosphoric acid, another, perhaps, uses 65 lbs., while a third may use 3 cwt. of some phosphate without regard to its contents of phosphoric acid. This means all-round waste of energy, and renders definite comparison of the results impossible.

By voluntary association, one special four-course rotation experiment is being carried out by the Durham College of Science, the Yorkshire College, Cambridge University, the South-Eastern Agricultural College and Nottingham University College. The present season will see the close of this experiment at three of the centres, and the results are likely to be much more valuable than if the work had been entirely uncoordinated. Major Craigie, in his report, directs special attention to this experiment, as also to the fact that the Board has

made arrangements for the repetition in the south and centre of England of the Northumberland "manuring for mutton" experiment. This work, started in the spring of 1897, took the form of determining the results of the manurial treatment of grass land, not in terms of hay, but in the terms of live-weight increase. Ten three-acre plots were fenced off on a large field of poor pasture, and nine of these plots were subjected to as many distinct forms of treatment. The plots have each year been grazed by sheep, each plot being stocked with as many animals as a committee of practical farmers considered it would carry. The individual weights of the animals are determined by monthly weighings. During the first season (1897) variations in the yield of animal increase were fairly pronounced; while in the second, third and fourth years the results have been extremely striking. Lime, used alone, has almost failed to act; while phosphates, especially basic slag, have, in some cases, enabled the land to carry twice as many sheep as the untreated area, and not only so, but the animals have given more than double the individual live-weight increase. The addition of sulphate of ammonia or potash to a phosphatic dressing has had extremely little influence, whereas the beneficial effects of a similar addition of pulverised lime have been very conspicuous. The yield of hay on separate sub-plots gave but a modified reflection of the mutton results, showing that the manures have had much more influence on the quality than on the quantity of the herbage. By a single expenditure of about twenty shillings per acre on manure, it has been shown that land worth five shillings per acre per annum has been—temporarily at least—raised in value to five or six times this sum. Whether such a result will be obtained in other parts of the country it would be hazardous to predict, but there can be no question of the desirability of putting the matter to the test, and it is satisfactory to find that the Board has made arrangements to do so.

The past ten years may be regarded as a period of adjustment in the history of the provincial agricultural colleges. They were called into being as a result of the sudden endowment of county councils with large funds, and practically no preparations had been made for their reception. They were placed in the receipt of grants from public bodies, and these bodies naturally wanted results for their money. If these results could be made to loom large in the eyes of the county council electorate, so much the better. The success of a local lecture was judged rather by the size of the audience than by any educational standard. The county councils vied with each other as to the number of field demonstrations they could show. But things are different now. Both colleges and county councils have elaborated educational schemes, and work will in the future be tested by its intrinsic quality. Now that the feverish incentive to the production of results has been replaced by a demand for thoroughness, it is to be hoped that the colleges will be allowed to settle down to do some first-class work. But, with the best intentions, county councils sometimes handicap the staff of the institutions that they support. It is quite impossible that a department of agriculture can develop in such a way as to do justice to its students, or to take its proper place amongst the other departments of a college or University if a large portion of the time of the members of its staff has to be spent away from headquarters. The local work that they are doing may be of the greatest importance, but the time occupied in its preparation and accomplishment makes a serious inroad on the efficiency of in-college work. It is to be hoped that county councils will give their support to central institutions without being too exacting in their local demands upon them, while the Board of Agriculture should be endowed with funds sufficient to enable the agricultural departments of the colleges to prosecute the highest forms of research.

WM. SOMERVILLE.

HORTICULTURAL PRACTICE.

ONE method by which the gardener "improves" particular plants was well illustrated at the Hybridisation Conference held in the gardens of the Royal Horticultural Society last year. The proceedings of that meeting were amply recorded in these columns at the time, so that there is no need to do more than mention that branch of the subject. Another method of improvement consists in the continuous selection of the best and the cotemporaneous elimination of inferior varieties. This is the method followed by the great seed-firms, who devote large areas to their trial grounds and take the greatest pains to secure and maintain the purity of their stocks. A variation may arise from seed or from "sports," the latter term being applied to bud-variations which occur suddenly, no one knows why. If the variation be a desirable one, the cultivator preserves the seed, sows it, and in due time finds that a certain percentage of the seedlings reproduces the desired form. Further sowings take place, the percentage of the new variation being constantly increased till at length the seeds are said "to come true," and a new species, at any rate so far as gardens are concerned, is evolved by the constant practice of selection.

In the case of a sport, propagation is effected by cuttings or grafts.

The advent of the Chrysanthemum season reminds us of other practices which the gardener adopts with the view of securing "improvement." Those who visited the recent exhibitions at the Royal Horticultural Society and at the Westminster Aquarium must have been forcibly struck with the contrast between the wild Chinese Chrysanthemum and the Japanese varieties, which constituted the essential part of the exhibition. The wild plant, sent from the Royal Gardens, Kew, was discovered in central China. Horticulturally it was but a poor weed, with small yellow flower-heads about half an inch in diameter, by no means so attractive as our own corn-marigold. Yet from this plant, either alone or when crossed with another species, the Chinese and the Japanese have evolved flowers of every shade of colour except blue, and the gardener has produced flowers 15 and 18 inches in diameter.

The Japanese varieties, originally introduced by Fortune in 1862, at once attracted attention by their large size and fantastic form. It is these Japanese varieties that now constitute the staple of our exhibitions, and their size and colour offer, as we have said, the greatest possible contrast to the inconspicuous flowers of the wild plant. They are purely artificial productions, and nothing like them occurs in nature, although occasionally, in Composites, malformations occur in the ray-florets which give a clue to the origin of these strange productions.

It is mainly to the art of the gardener that we owe these monstrous blooms. That art consists essentially in "disbudding" or in removing certain buds and leaving others. As the history is interesting and not generally known in scientific circles, it may be well briefly to summarise the facts of the case. The "first break" or lateral bud of a Chrysanthemum makes its appearance from the middle of April to the middle of June, the precise period differing in the case of different varieties. The second or "crown" bud appears in August, and consists of a flower-bud surrounded by leafy shoots, which grow sympodially; these are removed, and the development of the central flower-bud allowed to proceed. The third or "terminal" bud is formed in September, and always consists of one central bud surrounded by other secondary flower-buds, but not by any leaf-shoots. The secondary flower-buds are removed, and all the energy of the plant concentrated in the central bud, which, in florists' language, is "taken," or, more correctly, which is reserved.

Lastly, in December, after the flowers are over, a quantity of leaf-buds are produced from the base of the stem. These are used as cuttings.

Dis-budding is a common enough procedure in roses and other flowers grown for exhibition; but the peculiarity in the Chrysanthemum is the difference in the position, time of formation, and nature of the buds. The practice varies in accordance with these differences. Different varieties demand different treatment. In some instances the bud must be "taken" at this time, in other cases at a different period. In some varieties the best blooms are produced by the "crown" buds; in others it is the terminal buds that produce the finest flowers. All this is determined by experiment, but in any case this variation in the position, form and time of development of the buds is sufficiently important to attract the attention of the physiologist.

Another practice now much followed is that of retarding the growing and flowering period of plants by means of cold. By this means flowers, say of lily of the valley, can be had at any season that may be desired.

The chief point of physiological interest appears to reside in the fact that plants can be subjected without injury to much lower degrees of cold than was formerly supposed.

SOME REMARKABLE EARTHQUAKE EFFECTS.

MR. R. D. OLDHAM'S elaborate report on the great earthquake of June 12, 1897, published in the *Memoirs* of the Geological Survey of India (vol. xxix.), has been referred to on several occasions in these columns; and an abstract has been given of its most important contents (vol. lxii. p. 305, July 26, 1900). There are many striking illustrations of earthquake effects in the report, and three of the plates are here reproduced.

That pillars and other similar objects may be left standing, but with one part twisted round upon another, has long been known as a fantastic effect of severe earthquakes, and even in some cases of earthquakes which can scarcely be called severe. There is, however, no instance where cases of this kind were so numerous, and so various in the nature of the object rotated, as the Indian earthquake. The most imposing and striking of the many instances of twisting found by Mr. Oldham is that of the monument to George Inglis, erected in 1850 at Chhatak. This conspicuous landmark takes the form of an obelisk, and, rising from a base 12 feet square, must have been over 60 feet high before the earthquake. It is built of broad, flat bricks, or tiles, laid in mortar and plastered over, and is represented in its present state in Fig. 1. About 6 feet of the monument was broken off and fell to the south, and 9 feet to the east. Of the remainder, the top 20 feet was separated at a height of about 23 feet from the ground, and twisted in the opposite direction to that of the hands of a watch lying face upwards on the ground.

The view in Fig. 2 shows some tombs in the cemetery at Cherrapunji. All the tombs are of the oblong form with sloping tops, and are built of rubble stone masonry. Few are broken up, but nearly all have sunk down into the loose sand beneath them, and are leaning over at various angles to the north. The cemetery is situated on the top of one of the small knolls of sandstone which are scattered over the Cherra plateau. This sandstone originally rested upon the limestone of the plateau, which has been dissolved away from beneath it, and is accordingly much broken. The earthquake seems to have shaken the surface down into a perfect quicksand, into which the tombs sank.

A direct measure of the amplitude of the earth-wave, or of the greatest movement of the wave particle backward and forward, was obtained at Cherrapunji. Mr. Oldham concludes, from observations of the length of a depression scooped out by the movement of the ground against some tombs which remained stationary, that the extreme range of motion cannot have been less than ten inches, may have been as much as eighteen inches, and was probably about fourteen inches. The amplitude or range of the wave particle on either side of its original position would be half these amounts.

FIG 1.—Monument at Chhatak, with part twisted by earthquake. The part of the monument left standing is about 46 feet high.

The banks of the Brahmaputra are fissured at intervals on each side along a length of 260 miles, and fissures extend along the banks of all the minor branches of the river and its tributaries within the disturbed area. As a rule, the fissures run parallel to the bank of the river, and where this is not the case, some peculiarity in the contour of the ground—a drop, for instance, from a higher to a lower level—can usually be found to account for the

FIG. 2.—Tombs in cemetery, Cherrapunji.

change of direction. At Rowmari, for instance, besides the fissures parallel to the bank of the Brahmaputra, which here runs nearly north-east and south-west, a large fissure runs to the south-east at right angles to the river bank for a distance of at least 500 yards, where it becomes lost in a jheel, and is said to be traceable for a distance of nine miles. Sand and mud were ejected from the fissure to a depth of at least four feet. Other fissures

FIG. 3.—Fissure at Rowmari.

branch off from this. Subsequent to the ejection of the sand, the surface sank down to a depth proportional to the amount of material ejected, and several crater-like hollows were formed as the water drained back into the fissure. Illustrations of this and many other effects are given by Mr. Oldham, and his complete report upon the Indian earthquake, in all its scientific aspects, is a memoir which will take its place among classical papers on seismology.

INVESTIGATIONS OF THE HABITS AND FOLK LORE OF AUSTRALIAN ABORIGINES.

EARLY in the summer a memorial was submitted to the Governments of South Australia and Victoria praying that facilities might be granted to Mr. Gillen, one of the inspectors of aborigines, and Prof. Baldwin Spencer for the continuance of their investigations into the habits and folk-lore of the natives of Central Australia and the Northern Territory. The memorial, which was signed by all British anthropologists and many prominent representatives of other sciences, has met with a prompt and generous response. The Government of South Australia has granted a year's leave of absence to Mr. Gillen, and the Government of Victoria has provided a substitute for Prof. Spencer during his absence from Melbourne. Mr. Syme, the proprietor of the Melbourne *Age*, has contributed 1000*l.* towards the ordinary expenses of the expedition. The Government of South Australia has also allowed the expedition to make use of the depôts and staff of the Transaustralian telegraph for the forwarding and storage of supplies. The explorers start in February, and it may be confidently anticipated that, if the winter rains make conditions favourable for travelling, they will be rewarded with the same conspicuous success which attended their expedition of three years ago; although the task before them requires even greater tact, since the natives of the Northern Territory are more difficult to deal with than the aborigines of the centre, who know Mr Gillen and regard him with the utmost confidence. The tribes of the MacDonnell Ranges will be studied even more minutely than before, and afterwards the explorers will go towards the Gulf of Carpentaria, along the Roper River, and, time permitting, proceed down the Daly and Victoria Rivers.

To quote from the *Adelaide Advertiser* of October 4, "It scarcely needs a scientific mind to appreciate the value of the task which Messrs. Gillen and Spencer are about to renew, and possibly complete. The mystery their labours will contribute to unveil may well captivate the fancy of the most unlearned 'man in the street.' . . . The breath of the white man has scorched out of existence so many aboriginal races and tribes that civilisation may be thankful that there are still untutored savages left to throw light on its own beginnings."

NOTES.

SIR JOSEPH HOOKER has been elected a Foreign Associate of the Paris Academy of Sciences.

THE death is announced of Prof. G. F. Armstrong, Regius professor of engineering at Edinburgh University since 1885.

THE death is announced of the Rev. Father Armand David, Correspondant of the Paris Academy of Sciences, in the Section of Geography and Navigation.

WE learn from the *Athenaeum* that the Amsterdam Society for the Advancement of Medical and Natural Science has conferred its Swammerdam Medal upon Prof. Carl Gegenbauer, of Heidelberg.

DR. HERMAN S. DAVIS, recently expert computer of the U. S. Coast Survey, has been appointed observer at the International Latitude Observatory at Gaithersburg, Maryland, one of the six stations established by the Centralbureau der Internationalen Erdmessung for an investigation of variations of latitude.

WE are asked to announce that the Thomson Foundation Medal of the Royal Geographical Society of Australasia will be awarded to the author of the best original paper on each of the following subjects:—(1) The commercial development, expansion and potentialities of Australia—or, briefly put, the commerce of Australia. To be sent in not later than October 15, 1901. (2) The pastoral industry of Australia, past, present and probable future. To be sent in not later than June 15, 1902.

THE College of Physicians of Philadelphia announces that the next award of the Alvarenga Prize, being the income for one year of the bequest of the late Señor Alvarenga, amounting to about 180 dollars (36*l.*), will be made on July 14, 1901, provided that an essay deemed by the Committee to be worthy of the prize shall have been offered. Essays intended for competition may be upon any subject in medicine, but must be unpublished. They must be received by the secretary of the college on or before May 1, 1901. The Alvarenga Prize for 1900 has been awarded to Dr. David de Beck, of Cincinnati, Ohio, for his essay entitled "Malarial Diseases of the Eye."

We learn from *Science* that the New York Board of Health is building, at a cost of 4000*l.*, a laboratory to be wholly devoted to the study of the bubonic plague. Special care will be taken in its construction. The ground floor will be occupied chiefly with eight stalls for horses that will supply the anti-plague serum. A staircase from the outside will lead to the upper floor, where experiments will be carried on. The walls and floor are to be of steel and cement, so as to be rat proof, and the windows are to be especially screened to keep out flies and mosquitoes.

IT will be remembered that shortly after the death of the late Mr. G. J. Symons, F.R.S., the founder of the British Rainfall organisation, a movement was started for the foundation of a memorial to him. It was resolved that the memorial should take the form of a gold medal, to be awarded from time to time by the Council of the Royal Meteorological Society for distinguished work in connection with meteorological science. The committee appointed to take the necessary steps to raise a fund for that purpose announce that the appeal has met with a hearty response from meteorologists, water engineers and other admirers of Mr. Symons's work. The fund will be open until the end of January next, and subscriptions should be sent to the treasurer, Dr. C. Theodore Williams, 70, Victoria Street, Westminster.

THE Vienna correspondent of the *Times* states that two facts of considerable importance, both to sanitary authorities and the general public, are set forth in the definitive report of the Austrian Medical Commission of the Vienna Imperial Academy of Science, sent to Bombay in 1897 to study the issue of a work on the morphology and biology of the bacillus and on artificial infection, &c. It has been prepared by Drs. Albrecht and Ghon, both surviving colleagues of Dr. Müller, who died of the plague in Vienna two years ago under melancholy circumstances reported at the time. The experiments recorded in the work now published show that certain species of animals are easily infected by rubbing the virulent matter lightly on the skin even when it is perfectly intact and free from injury. This is said to be the most frequent and important form of infection in the case of human beings. The second result of the experiments conducted in Vienna, which were forbidden after the unfortunate accident that cost the life of Dr. Müller and two other victims in 1898, has been to prove that perfect immunity can be given to the most susceptible animals against injections which would otherwise be absolutely fatal.

THE mode of infection with plague was referred to by Prof. A. Calmette in the second Harben lecture, delivered at the Examination Hall of the Royal College of Physicians and Surgeons on November 14. In the course of his lecture, Prof. Calmette said (reports the *Lancet*) that certain epidemics of plague had been remarkable for the fact that all the cases presented a primitive pneumonic form, the mode of entry having been, therefore, exclusively through the nose or mouth, while in others the infection had been produced by the skin, either following slight excoriations or bites of fleas, bugs, and other parasitical insects. During the epidemic in Portugal last year, he observed with Salimbeni a case in which the infection was through a bug-bite. Hankin and Simond, in India, had cited several examples of individuals who had contracted plague from touching diseased or dead rats. It was probable that the transmission of the plague to the man was by fleas living on the rats. Experiment in the laboratory had shown how quickly a healthy rat would contract the plague if caged with a diseased rat which was infested with fleas, while a healthy rat remained healthy when shut up with one which was diseased but was free from fleas. Whatever the mode of entry of the virus, multiplication of the plague bacillus resulted first in the lymphatic channels and then in the blood.

THERE ought to be a ready and liberal response to the appeal for contributions to establish a permanent memorial to the late Miss Mary Kingsley; for her works on the customs and institutions of the native races of West Africa are admired by a large public. A strong and representative committee has been formed, and it has been decided that, if sufficient funds are obtained, the memorial shall take the form of a small hospital, to be established in connection with the Liverpool School of Tropical Medicine, and shall also be used to institute "The Mary Kingsley Society of West Africa," to stimulate research and collect information concerning West Africa. Much information of the required kind as to West African sociology is already on record, scattered through the works of the older writers on those parts, as well as in more recent books of travel, in papers published in periodicals, in Blue-books and in official reports; and a very great deal more may still be gathered by Government officials, traders, missionaries, travellers and by the small but remarkable band of natives who are already educated. It is proposed that the "Mary Kingsley Society" should employ a trained ethnologist, both to collect and arrange in scientific form the material which is thus already on record, and to institute and direct research for further material of the same sort. Subscriptions may be assigned by the donors to either the hospital or the society, and the two funds will be kept separate. Contributions for the "Mary Kingsley Memorial Hospital" should be sent to Mr. A. H. Milne, B. 10, Exchange Buildings, Liverpool, and for the "Mary Kingsley Society of West Africa" to Mr. George Macmillan, St. Martin's Street, London, W.C.

THE U.S. Pilot Chart of the North Atlantic Ocean for November gives the longitude at which a number of vessels bound round Cape Horn crossed the latitude of 50° S. in the Atlantic and the Pacific respectively, and shows the courses followed by ships making the best and worst passages. The time occupied varied from eight to thirty days. Some of the captains kept as closely as possible to Cape Horn, while others reached the parallel of 60° S. In no other part of the world are the meteorological conditions more trying, owing to the persistency and violence of the westerly winds, the turbulence of the sea and frequent blinding squalls of hail and sleet. The Hydrographic Office has, therefore, rendered good service in pointing out the route to be followed, and the necessity of adapting it to the prevailing meteorological conditions, especially with regard to barometric pressure. A vessel fortunate enough to encounter easterly winds in rounding the Horn can only retain them as long as possible by remaining on the southern side of the low barometric pressure which they surround, instead of standing at once to the N.W., regardless of the indications of the barometer.

THE report of the Prussian Meteorological Office for the year 1899 points with satisfaction to the increased uniformity of action between all the German States as regards the methods of discussion and publication of observations, and to the tendency towards augmenting the number of observing stations where necessary. An important investigation has been carried out by Dr. Edler, at the suggestion of Dr. v. Bezold, on the influence of stray currents from electric tramways on the instruments for measuring terrestrial magnetism, with a view to determining the minimum distance to which magnetic observatories should be removed. The result shows that the observatory must be at least five miles from the line, and, for researches of a delicate nature, at least twice that distance is required. Special attention is paid to the investigation of the upper air by means of kites and balloons. Two of the unmanned balloons reached, during the year in question, about 22,000 and 26,000 feet respectively, and we learn from other sources that these important investigations are being actively carried on during the current year.

IN the *Journal* of the College of Science, Imperial University of Tokio, Prof. H. Nagaoka and Mr. K. Honda discuss the changes of volume and of length in iron, steel and nickel ovoids by magnetisation, and a separate paper by Mr. K. Honda deals with the combined effect of longitudinal and circular magnetisation on the dimensions of tubes of these metals. Among various results of the combined investigation we notice that:—(1) the transient current, as well as the longitudinal magnetisation produced, by twisting an iron or steel wire is opposite to that produced by twisting one of nickel up to moderate fields; (2) the transient current, as well as the longitudinal magnetisation produced, by twisting an iron, steel or nickel wire reaches a maximum in low fields; (3) in strong fields the direction of the current, as well as the longitudinal magnetisation, is the same in iron, steel and nickel. In alluding to this work we cannot but draw attention to the evidence of Japanese enterprise that is afforded by the publication of a journal containing scientific papers in English and German by Japanese professors and university graduates.

IN the *Philosophical Magazine* for September Dr. Sydney Young discusses the Law of Cailletet and Mathias, according to which the mean of the densities of a liquid and its saturated vapour for any stable substance is a rectilinear function of the temperature. It appears, among other results of this investigation, that the law, though approximately satisfied, is not absolutely true unless the ratio of the actual to the theoretical density at the critical point has the normal value 3·77. In most cases if the mean density be expanded in powers of the temperature, the sign of the coefficient of the second power depends on whether the ratio in question is greater or less than the normal. The coefficient of the second power is so small that the linear formula may be used to calculate the critical density from observations at temperatures above the boiling point, but the error thus introduced becomes considerable if it be required to calculate the critical density from observations of mean densities at lower temperatures; moreover, as pointed out by Guye, the law fails when the molecules differ in complexity in the liquid and gaseous states.

IN the *Journal de Physique* for September, M. E. Mathias discusses two interesting groups of loci relating to the thermodynamic properties of a liquid in presence with its saturated vapour. The first is the locus in the (p,v) plane of points, such that the volume of the liquid is equal to that of the vapour (the total mass being unity). This locus, the author finds, is a curve constantly convex towards the axis of abscissæ, and is the only one of the curves defined by the constancy of the ratio of the volumes of the liquid and vapour, which cuts the curve of saturation at a finite angle at the critical point. M. Mathias proves that the locus has no point of inflexion, but that the angular coefficient increases with the temperature. The second group discussed consists of the curves for which the masses of the liquid and vapour are constant. In accordance with Raveau's investigation, the only one of these curves which cuts the curve of saturation at a finite angle is that corresponding to equal masses of liquid and vapour.

MR. S. H. BURBURY communicates to Wiedemann's *Annalen* a reply to certain objections raised by Herr Zemplén Győző against his modifications of the Kinetic Theory of Gases. In it he gives certain amplifications of his proof of the property that the mean values of the products of velocities of neighbouring molecules of a gas are positive, and discusses the point at which his method diverges from those leading to the ordinary Boltzmann-Maxwell distribution.

THE U.S. Department of Agriculture has issued a bulletin containing records of investigations made by Mr. M. E. Jaffa, at the Agricultural Experiment Station of the University of California. A number of analyses of food materials were made, and dietary studies were conducted with a football team and with a chemist's family, as well as with a number of infants. In one instance the metabolism of nitrogen of an infant was also studied. Such investigations cannot fail to furnish aid in fixing upon dietary standards, and the proper factors to be used in computing the amounts eaten by persons of different ages as compared with an adult man.

FROM Messrs. B. O. Peirce and R. W. Wilson we have received a paper on the thermal diffusivities of different kinds of marble, published in the *Proceedings* of the American Academy of Arts and Sciences, xxxvi. 2. The tables which the authors give of the specific heats of various marbles are useful for several purposes, and the law of variation of the specific heat of dry Carrara marble with the temperature appears to be well represented by the formula $S = 0{\cdot}1844 + 0{\cdot}000379\, t^2$.

AT the last meeting of the Liverpool Geological Society, a paper was read on the carboniferous limestone of Anglesey, by the late Mr. G. H. Morton. The paper was left by the author in a finished state, and was intended by him to be the concluding portion of the series of papers on the carboniferous limestone of North Wales, on which he had been engaged for a period of nearly forty years. We are informed that, in addition to the paper itself, Mr. Morton left revised lists of fossils brought up to date with their comparative rarity or otherwise, for the districts previously described, but unfortunately the list for Anglesey was not completed, as he intended to visit one or two localities this summer to check his lists. It is intended to print the completed lists, but not the Anglesey list. Lists for certain localities in Anglesey were incorporated by Mr. Morton with his paper, which will be printed in full in the Society's *Proceedings*.

A LECTURE on the coal resources of Victoria, Australia, was delivered at the Imperial Institute, on Monday evening, by Mr. James Stirling, mining representative of the Colony. The attention of most nations is now turned to their coals. The demand to-day, owing to the rapid development of industries and extension of commerce, is greater than it has ever been before. The Australian Colonies have large areas of coal-bearing territory, and up to the present have produced a million tons of coal, the largest output having been from New South Wales. After giving a short account of the first discovery of coal in Victoria, Mr. Stirling said that about ten years ago he had been deputed to investigate the Gippsland coalfields, and he had been able to prove that within an area of 3,000 square miles of Jurassic rocks there were a number of seams of good black coal from 2 to 5 feet in thickness. But it is in brown coal that Victoria is specially rich. From borings carried on over a distance of 50 miles in the Latrobe Valley, Mr. Stirling has estimated that there cannot be less than 31,144,400,000 tons of brown coal. In several places shafts had been sunk through beds of from 20 to 200 feet thick, and at one place a coal bed, 70 feet thick, is being worked as a quarry by open face. Various analyses of these coals have shown them to be superior to the average German brown coal, and to have a much smaller percentage of ash. Austria, Germany and Italy have put their smaller deposits of this coal to commercial uses by compressing it into briquettes, distilling oils, etc., and the same could be done in Victoria, besides converting the fuel directly into electrical energy.

THE Geological Survey has published the second part of "The Geology of the South Wales Coal-field," in which the country around Abergavenny, included in the new series map, No. 232, is described by Messrs. A. Strahan and W. Gibson. A study of

the northern part of the Usk inlier of Silurian rocks confirms the opinion that a well-defined plane of division separates these strata from the Old Red Sandstone. A small portion of the Black Mountains, with the Old Red Sandstone Sugar Loaf, and the fine escarpment of the Blorenge, formed of Old Red Sandstone and Lower Carboniferous rocks, come in for description, to which Mr. J. R. Dakyns contributes. The Carboniferous Limestone displays the phenomenon of dolomitisation with unusual clearness, and notes on microscopic sections of the rock are contributed by Prof. W. W. Watts. Special attention is naturally given to the Coal-measures, and it is pointed out that while the coals are more extensively worked than formerly, the iron-ores are now hardly worked at all. The Glacial Drifts present many features of interest, notably in the case of a transported mass of Carboniferous grit, which forms a small hill upwards of 200 yards in length, and rests on Boulder Clay.

IN the October issue of the *American Naturalist*, Prof. H. F. Osborn reconsiders the evidence in favour of the existence in the Permian of a common ancestral stem from which have diverged dinosaurs and birds. It is argued that many of the resemblances between these groups are adaptive rather than genetic, while the apparent close correspondence in the structure of the pelvis between adult birds and the herbivorous dinosaurs (which are specialised types) is due in a considerable degree to a misinterpretation of the homology of some of their elements. Nevertheless, the resemblances between the two groups are so numerous as to justify the belief of kinship. And special importance attaches to the opinion that some sort of bipedalism was a common character of all dinosaurs, the suggestion being countenanced that certain forms, like Stegosaurus, have reverted from a bipedal to a quadrupedal mode of progression. Our present knowledge, therefore, justifies us in saying that "in this bipedal transition, with its tendency to form the tibiotarsus, the avian phylum may have been given off from the dinosaurian. This form of the Huxleyan hypothesis seems more probable than that the avian phylum should have originated quite independently from a quadrupedal proganosaurian reptile, because the numerous parallelisms and resemblances in dinosaur and bird structure, while quite independently evolved, could thus be traced back to a potentially similar inheritance."

VOLUME II., part 3, of the *Annals* of the South African Museum is occupied by the continuation of Sir George Hampson's synopsis of the moths of South Africa.

THE interest attaching to the great skua gull, on account of its narrow escape from extermination in the Shetlands, will cause many ornithologists to hail with satisfaction the account of its habits in the southern hemisphere, published by Mr. R. Hall in the October number of the *Victorian Naturalist*. The extent of the geographical range of this bird—from the Shetland Islands past Kerguelen's Land to New Zealand, and sparingly between the Cape of Good Hope, Ceylon and Southern Australia—is very remarkable.

THE latest issue of the *Morphologisches Jahrbuch* (vol. xxix. part 1) contains the results of an elaborate investigation by Dr. O. Grosser into the anatomical structure of the nasal cavity and throat of the species of bats indigenous to Germany. In the same number Prof. L. Balk describes and figures a human vertebral column presenting the rare abnormality of only six (instead of seven) cervical vertebræ. The comparative anatomy of the eye-muscles forms the subject of a communication by Herr H. K. Corning; while the nature of the partition between the pericardiac and peritoneal cavities engages the attention of Herr F. Hochstetter.

THE first three parts of a lavishly illustrated work on the "Living Races of Mankind" have been published by Messrs. Hutchinson and Co. The work is by the Rev. H. N. Hutchinson, the author of "Extinct Monsters" and other works of popular natural science, assisted by Prof. J. W. Gregory and Mr. R. Lydekker, F.R.S. There will be eighteen parts, published at fortnightly intervals, and when complete the work will be an attractive, as well as instructive, account of the customs, habits, pursuits, feasts, and ceremonies of the peoples of the world. Much care and trouble have been expended in collecting the photographs to illustrate the text, and it is to be hoped that the enterprise will meet with success. It is highly important that the British public should be interested in the study of ethnology, and the work now in course of publication will assist in attaining this end.

A FEW weeks ago Sir William White, the president of the Institution of Mechanical Engineers, brought before the Institution a letter from the Association of German Engineers suggesting that scientific and technical societies in the United States, France, Germany and England should unite in the preparation of an English, French and German technical dictionary. It was decided not to officially take part in the scheme, but the members of the Institution were invited to assist in the work. We are reminded of this by the appearance of the second volume of a "Practical Dictionary of Electrical Engineering and Chemistry, in German, English and Spanish," by Mr. Paul Heyne, which has just been received from Messrs. H. Grevel and Co. The dictionary is published in three volumes, one with German words alphabetically arranged, and their English and Spanish equivalents in parallel columns, and the two other volumes with English and Spanish words alphabetically arranged. The dictionary should be of value in manufactories and business houses concerned with engineering work.

THE second volume of "A Hand-List of the Genera and Species of Birds," by Mr. R. Bowdler Sharpe, has been issued by the Trustees of the British Museum. This volume contains the parrots and those birds commonly known as "Picarians," thus leaving the Passerines for the third volume. We propose to postpone a detailed notice of this useful work till the issue of the last volume.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. D. Nagle; a Barbary Ape (*Macacus inuus*) from North Africa, presented by Mr. Thomas Pink; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mr. C. W. Labarte; two Black Kites (*Milvus migrans*) from East Africa, presented by Mr. Campbell Hansburg; two Auriculated Doves (*Zenaida auriculata*) from South America, presented by Mrs. Aston; a Redbreast (*Erithacus rubecula*), British, presented by Canon Wilberforce; a Common Fox (*Canis vulpes*), British, presented by Mr. W. B. Spiers; a Horned Lizard (*Phrynosoma cornutum*) from California, presented by Mr. H. L. Brackenbury; a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Mr. Small; two Brown Hyænas (*Hyaena brunneus*, ♂ ♀) from South Africa, a Common Wolf (*Canis lupus*, white var.), European, a Crab-eating Raccoon (*Procyon cancrivorus*) from South America two Rosy Parrakeets (*Palaeornis rosa*, ♂ ♀) from Burmah, two Vernal Hanging Parrakeets (*Loriculus vernalis*) from the East Indies, a Malabar Mynah (*Poliopsar malabaricus* from Hindostan, a Grey Monitor (*Varanus griseus*) from North Africa, three Giant Toads (*Bufo marinus*) from South America, deposited; an Indian Cobra (*Naia tripudians*) from the East Indies, purchased.

OUR ASTRONOMICAL COLUMN.

THE LEONID METEORS.—As was anticipated, the Leonid meteors failed to appear in any numbers last week. In a letter to the *Times*, Mr. W. H. M. Christie, the Astronomer Royal, states that a watch was kept at the Royal Observatory on the nights of November 13–14, 14–15 and 15–16, but comparatively few Leonids were seen. The following is a statement of the number of meteors noted by three observers on the three nights in question:—

	Length of watch.	Total number of meteors.	Number of Leonids.
November 13–14	5 hours	25	5
,, 14–15	2 ,,	20	6
,, 15–16	4½ ,,	55	23

It will be seen that there was nothing in the nature of a shower of Leonids.

Mr. E. C. Willis, writing from Norwich, says:—"Watches for the Leonids were first undertaken on the morning of November 10, and continued at various intervals until the evening of November 16. The total duration of the actual watches was 12¼ hours, but a considerable portion of this time was more or less cloudy, and the moon was above the horizon nearly the whole of it. The total number of Leonids recorded was 42, while the other meteors numbered 110. No Leonids were observed before the morning of November 11, or after the morning of November 16, and although it is no doubt very possible that the shower may have extended over a much longer period, it is certain that in that case it must have been of a very weak character.

"To determine the true maximum of the shower, it is necessary to combine the records of observers from various parts of the earth's surface, so as to obtain a continuous record. The maximum, however, as deduced from my own observations only, decidedly occurred on the morning of November 14. On this occasion the Leonids numbered about two-thirds of all the meteors seen, while on every other occasion they were decidedly in the minority. The hourly rate was about thirteen, but it is evident that many more would have been seen if the conditions had been more favourable, as hardly any of those observed were of less than the second magnitude. This portion of the shower seems to have ended a little before 17h. 30m., as between that time and 18h. none were observed.

"Perhaps the most remarkable point brought out by the observations was the extraordinary paucity of Leonids on the night of November 15. Watches were kept for 2¼ hours at various times between 11h. 15m. and 16h. 15m. In all, 32 meteors were seen, but only two of these were Leonids."

Prof. J. P. O'Reilly, of Dublin, informs us that on November 13, at about 5.51 p.m., he observed "a shooting star of much brilliancy, which seemed to start from about the Pleiades and to shoot in the direction of the south in a rising direction of about 25° to 30° with the horizon, and being visible over an arc of about 12° to 15°."

Balloon ascents were made from Paris on the nights of November 14, 15 and 16, but only a few stray meteors were seen.

ELEMENTS OF COMET 1900*b* (BORRELLY-BROOKS).—Prof. C. D. Perrine gives the following computed elements of this comet in the *Astronomical Journal*, No. 484, vol. xxi.:—

T = 1900 August 3d. ·20726 G.M.T.

$$\left.\begin{array}{l}\omega = 12^\circ\ 26'\ 13''\cdot2 \\ \Omega = 328\ \ 0\ \ 30\cdot1 \\ \iota = 62\ \ 30\ \ 46\cdot3\end{array}\right\}1900\cdot0$$

$$\log. q = 0\cdot006390$$

NEW VARIABLE STAR IN LYRA.—Mr. A. Stanley Williams has detected another small variable in Lyra, and in the *Astronomische Nachrichten*, Bd. 153, No. 3671, gives the following co-ordinates for its position:—

$$\left.\begin{array}{l}\text{R.A.} = 18\text{h. } 54\text{m. } 22\text{s.} \\ \text{Decl.} = +34^\circ\ 45'\cdot5\end{array}\right\}(1855\cdot0).$$

The variation in brightness, as measured from photographs taken with a 4·4 inch portrait lens during the period 1899 September 2 to 1900 October 21, is from 9·3 to 11·0 magnitude. No regular series of observations are given, but the period would appear to be about thirty days.

VISUAL OBSERVATION OF CAPELLA (α-AURIGÆ).—Prof. W. W. Campbell having some time ago discovered that this star was a spectroscopic binary with a period of 104 days, and the discussion of its parallax with the calculated dimensions of the orbit suggesting the possibility that it might be seen as a visual double star, Prof. W. J. Hussey has made a number of careful examinations of it with the 36-inch Lick telescope. In the *Astronomical Journal*, No. 484, vol. xxi, he furnishes the result of his observations. From the spectroscopic results it was indicated that the most favourable dates of observation would be April 15, June 6 and July 28, as at these times the components would be at their maximum separation. During these observations no evidence of the duplicity of the star could be detected. On August 2 and 5 further examination was made, using powers of 1000, 1500, 1900 and 2600. With all powers the star image appeared round. The "seeing" on these latter days was excellent, and it is considered that any elongation of the image as great as the tenth of a second of arc would have been perceptible even with the lowest power. On one occasion colour screens of various shades were used to reduce the light, but the result was exactly as before.

HUXLEY'S LIFE AND WORK.[1]

I ACCEPTED with pleasure the invitation of your Council to deliver the first Huxley lecture, not only on account of my affection and admiration for him and my long friendship, but it seemed also especially appropriate as I was associated with him in the foundation of this Society. He was President of the Ethnological Society, and when it was fused with the Anthropological we, many of us, felt that Huxley ought to be the first President of the new Institute. No one certainly did so more strongly than your first President, and I only accepted the honour when we found that it was impossible to secure him.

But the foundation of our Institute was only one of the occasions on which we worked together.

Like him, but, of course, far less effectively, from the date of the appearance of "The Origin of Species," I stood by Darwin and did my best to fight the battle of truth against the torrent of ignorance and abuse which were directed against him. Sir J. Hooker and I stood by Huxley's side and spoke up for Natural Selection in the great Oxford debate of 1860. In the same year we became co-editors of the *Natural History Review*.

Another small society in which I was closely associated with Huxley for many years was the X Club. The other members were George Busk, secretary of the Linnean Society; Edward Frankland, president of the Chemical Society; T. A. Hirst; head of the Royal Naval College at Greenwich, Sir Joseph Hooker; Herbert Spencer; W. Spottiswoode, president of the Royal Society; and Tyndall. It was started in 1864, and nearly nineteen years passed before we had a single loss—that of Spottiswoode; and Hooker, Spencer and I are now, alas! the only remaining members. We used to dine together once a month, except in July, August and September. There were no papers or formal discussions, but the idea was to secure more frequent meetings of a few friends who were bound together by common interests and aims, and strong feelings of personal affection. It has never been formally dissolved, but the last meeting was in 1893.

In 1869 the Metaphysical Society, of which I shall have something more to say later on, was started.

From 1870 to 1875 I was sitting with Huxley on the late Duke of Devonshire's Commission on Scientific Instruction; we had innumerable meetings, and we made many recommendations which are being by degrees adopted.

I had also the pleasure of spending some delightful holidays with him in Switzerland, in Brittany, and in various parts of England. Lastly, I sat by his side in the Sheldonian Theatre at the British Assocation meeting at Oxford, during Lord Salisbury's address, to which I listened with all the more interest knowing that he was to second the vote of thanks, and wondering how he would do it. At one passage we looked at one another, and he whispered to me, "Oh, my dear Lubbock, how I wish we were going to discuss the address in Section D instead of here!" Not, indeed, that he would have omitted any part of his speech, but there were other portions of the address which he would

1 The first "Huxley Memorial Lecture" of the Anthropological Institute, delivered on November 13, by the Rt. Hon. Lord Avebury, F.R.S., D.C.L., LL.D.

have been glad to have criticised. I was therefore for many years in close and intimate association with him.

Huxley showed from early youth a determination, in the words of Jean Paul Richter, "to make the most that was possible out of the stuff," and this was a great deal, for the material was excellent. He took the wise advice to consume more oil than wine, and, what is better even than midnight oil, he made the most of the sweet morning air.

In his youth he was a voracious reader, and devoured everything he could lay his hand on, from the Bible to Hamilton's "Essay on the Philosophy of the Unconditioned." He tells us of himself that when he was a mere boy he had a perverse tendency to think when he ought to have been playing.

Considering how preeminent he was as a naturalist, it is rather surprising to hear, as he has himself told us, that his own desire was to be a mechanical engineer. "The only part," he said, "of my professional course which really and deeply interested me was physiology, which is the mechanical engineering of living machines; and, notwithstanding that natural science has been my proper business, I am afraid there is very little of the genuine naturalist in me; I never collected anything, and species work was a burden to me. What I cared for was the architectural and engineering part of the business; the working out the wonderful unity of plan in the thousands and thousands of diverse living constructions, and the modifications of similar apparatus to serve diverse ends."

In 1846 Huxley was appointed naturalist to the expedition which was sent to the East under Captain Owen Stanley in the *Rattlesnake* and good use indeed he made of his opportunities. It is really wonderful, as Sir M. Foster remarks in his excellent obituary notice in the Royal Society's *Proceedings*, how he could have accomplished so much under such difficulties.

"Working," says Sir Michael Foster, "amid a host of difficulties, in want of room, in want of light, seeking to unravel the intricacies of minute structure with a microscope lashed to secure steadiness, cramped within a tiny cabin, jostled by the tumult of a crowded ship's life, with the scantiest supply of books of reference, with no one at hand of whom he could take counsel on the problems opening up before him, he gathered for himself during those four years a large mass of accurate, important and, in most cases, novel observations, and illustrated them with skilful, pertinent drawings."

The truth is that Huxley was one of those all-round men who would have succeeded in almost any walk in life. In literature his wit, his power of clear description and his admirable style would certainly have placed him in the front rank.

He was as ready with his pencil as with his pen. Every one who attended his lectures will remember how admirably they were illustrated by his blackboard sketches, and how the diagrams seemed to grow line by line almost of themselves. Drawing was, indeed, a joy to him, and when I have been sitting with him at Royal Commissions or on committees, he was constantly making comical sketches on scraps of paper or on blotting-books which, though admirable, never seemed to distract his attention from the subject on hand.

Again, he was certainly one of the most effective speakers of the day. Eloquence is a great gift, although I am not sure that the country might not be better governed and more wisely led if the House of Commons and the country were less swayed by it. There is no doubt, however, that, to its fortunate possessor, eloquence is of great value, and if circumstances had thrown Huxley into political life, no one can doubt that he would have taken high rank among our statesmen. Indeed, I believe his presence in the House of Commons would have been of inestimable value to the country. Mr. Hutton, of the *Spectator*—no mean judge—has told us that in his judgment "an abler and more accomplished debater was not to be found even in the House of Commons." His speeches had the same quality, the same luminous style of exposition, with which his printed books have made all readers in America and England familiar. Yet it had more than that. You could not listen to him without thinking more of the speaker than of his science, more of the solid, beautiful nature than of the intellectual gifts, more of his manly simplicity and sincerity than of all his knowledge and his long services. His Friday evening lectures at the Royal Institution rivalled those of Tyndall in their interest and brilliance, and were always keenly and justly popular. Yet, he has told us that at first he had almost every fault a speaker could have. After his first Royal Institution lecture he received an anonymous letter recommending him never to try again, as whatever else he might be fit for, it was certainly not for giving lectures. It is also said that after one of his first lectures, "On the relations of Animals and Plants," at a surburban Athenæum, a general desire was expressed to the Council that they would never invite that young man to lecture again. Quite late in life he told me, and John Bright said the same thing, that he was always nervous when he rose to speak, though it soon wore off when he warmed up to his subject.

No doubt easy listening on the part of the audience means hard working and thinking on the part of the lecturer, and, whether for the cultivated audience at the Royal Institution or for one to working men, he spared himself no pains to make his lectures interesting and instructive. There used to be an impression that Science was something up in the clouds, too remote from ordinary life, too abstruse and too difficult to be interesting; or else, as Dickens ridiculed it in Pickwick, too trivial to be worthy of the time of an intellectual being.

Huxley was one of the foremost of those who brought our people to realise that science is of vital importance in our life, that it is more fascinating than a fairy tale, more thrilling than a novel, and that any one who neglects to follow the triumphant march of discovery, so startling in its marvellous and unexpected surprises, so inspiring in its moral influence and its revelations of the beauties and wonders of the world in which we live and the universe of which we form an infinitesimal, but to ourselves at any rate, an all important part, is deliberately rejecting one of the greatest comforts and interests of life, one of the greatest gifts with which we have been endowed by Providence.

But there is a time for all things under the sun, and we cannot fully realise the profound interest and serious responsibilities of life unless we refresh the mind and allow the bow to unbend. Huxley was full of humour, which burst out on most unexpected occasions. I remember one instance during a paper on the habits of spiders. The female spider appears to be one of the most unsociable, truculent and bloodthirsty of her sex. Even under the influence of love, she does but temporarily suspend her general hatred of all living beings. The courtship varies in character in different species, and is excessively quaint and curious; but at the close the thirst for blood which has been temporarily overmastered by an even stronger passion, bursts out, with irresistible fury, she attacks her lover and, if he be not on the watch and does not succeed in making his escape, ends by destroying and sucking him dry. In moving a vote of thanks to the author, Huxley ended some interesting remarks by the observation that this closing scene was the most extraordinary form of marriage settlements of which he had ever heard.

He seemed also to draw out the wit of others. At the York "Jubilee" meeting of the British Association, he and I strolled down in the afternoon to the Minster. At the entrance we met Prof. H. J. Smith, who made a mock movement of surprise. Huxley said "you seem surprised to see me here." "Well," said Smith hesitatingly, "not exactly, but it would have been on one of the pinnacles, you know."

His letters were full of fun. Speaking of Siena in one of his letters, contained in Mr. Leonard Huxley's excellent Life of his father, he says: "The town is the quaintest place imaginable, built of narrow streets on several hills to start with, and then apparently stirred up with a poker to prevent monotony of effect."

And, again, writing from Florence:—

"We had a morning at the Uffizii the other day, and came back with minds enlarged and backs broken. To-morrow we contemplate attacking the Pitti, and doubt not the result will be similar. By the end of the week our minds will probably be so large, and the small of the back so small, that we should probably break if we stayed any longer, so think it prudent to be off to Venice."

By degrees public duties and honours accumulated on him more and more. He was Secretary, and afterwards President, of the Royal Society, President of the Geological and of the Ethnological Societies, Hunterian Professor from 1863 to 1870, a Trustee of the British Museum, Dean of the Royal College of Science, President of the British Association, Inspector of Fisheries, Member of Senate of the University of London, Member of no less than ten Royal Commissions, in addition to which he gave many lectures at the Royal Institution and elsewhere, besides, of course, all those which formed a part of his official duties.

In 1892 he was made a Member of the Privy Council, an unwonted but generally welcome recognition of the services which science renders to the community.

As already mentioned, he was elected a Fellow of the Royal Society in 1851. He received a Royal Medal in 1852, the Copley in 1888, and the Darwin Medal in 1894.

Apart from his professional and administrative duties, Huxley's work falls into three principal divisions—Science, Education and Metaphysics.

SCIENTIFIC WORK.

Huxley's early papers do not appear to have in all cases at first received the consideration they deserved. The only important one which was published before his return was the one "On the Anatomy and Affinities of the Family of the Medusæ."

After his return, however, there was a rapid succession of valuable Memoirs, the most important, probably, being those on Salpa and Pyrosoma, on Appendicularia and Doliolum and on the Morphology of the Cephalous Mollusca.

In recognition of the value of these Memoirs he was elected a Fellow of the Royal Society in 1851, and received a Royal Medal in 1852. Lord Rosse, in presenting it, said: "In these papers you have for the first time fully developed their (the Medusæ) structure, and laid the foundation of a rational theory for their classification." "In your second paper, 'On the Anatomy of Salpa and Pyrosoma' the phenomena, &c., have received the most ingenious and elaborate elucidation, and have given rise to a process of reasoning the results of which can scarcely yet be anticipated, but must bear, in a very important degree, upon some of the most abstruse points of what may be called transcendental physiology."

A very interesting result of his work on the Hydrozoa was the generalisation that the two layers in the bodies of Hydrozoa (Polyps and Sea Anemones), the Ectoderm and the Entoderm correspond with the two primary germ layers of the higher animals. Again, though he did not discover or first define protoplasm, he took no small share in making its importance known, and in bringing naturalists to recognise it as the physical basis of life, and in demonstrating the unity of animal and plant protoplasm.

Among other important memoirs may be mentioned those "On the Teeth and the Corpuscula Tactus," "On the Tegumentary Organs," "Review of the Cell Theory," "On Aphis," and many others.

His palæontological work, for which he has told us that at first "he did not care," began in 1855. That "On the Anatomy and Affinities of the Genus Pterygotus" is still a classic; in another, "On the Structure of the Shields of Pteraspis," and in one "On Cephalaspis" in 1858 he for the first time clearly established their vertebrate character; his work "On Devonian Fishes" in 1861 threw quite a new light on their affinities; and amongst other later papers may be mentioned that "On Hyperodapedon"; "On the Characters of the Pelvis," "On the Crayfish," and one botanical memoir, "On the Gentians," the outcome of one of his Swiss trips.

One of the most striking results of his palæontological work was the clear demonstration of the numerous and close affinities between Reptiles and Birds, the result of which is that they are regarded by many as forming together a separate group, the Sauropsida; while the Amphibia, long regarded as Reptiles, were separated from them and united with Fishes under the title of Ichthyopsida. At the same time he showed that the Mammalia were not derived from the Sauropsida, but formed two diverging lines springing from a common ancestor. And besides this great generalisation, says the Royal Society obituary notice, "the importance of which, both from a classificatory and from an evolutional point of view, needs no comment, there came out of the same researches numerous lesser contributions to the advancement of morphological knowledge, including, among others, an attempt, in many respects successful, at a classification of birds."

In conjunction with Tyndall, he communicated to the *Philosophical Transactions* a memoir on glaciers, and his interest in philosophical geography was also shown in his popular treatise on physiography.

But it would be impossible here to go through all his contributions to science. The Royal Society Catalogue enumerates more than a hundred, everyone of which, in the words of Prof. S. Parker, "contains some brilliant generalisation, some new and fruitful way of looking at the facts of science. The keenest morphological insight and inductive power are everywhere apparent; but the imagination is always kept well in hand, and there are none of those airy speculations—a liberal pound of theory to a bare ounce of fact—by which so many reputations have been made." Huxley never allowed his study of detail to prevent him from taking a wide general view.

I now come to his special work on Man.

In the "Origin of Species," Darwin did not directly apply his views to the case of Man. No doubt he assumed that the considerations which applied to the rest of the animal kingdom must apply to Man also, and I should have thought must have been clear to every one, had not Wallace been in some respects, much to my surprise, of a different opinion. At any rate, it required some courage to state this boldly, and much skill and knowledge to state it clearly.

He put it in a manner which was most conclusive, and showed, in Virchow's words, "that in respect of substance and structure Man and the lower animals are one. The fundamental correspondence of human organisation with that of animals is at present universally accepted."

This, I think, is too sweeping a proposition. It may be true for Germany, but it certainly is not true here. Many of our countrymen and countrywomen not only do not accept, they do not even understand, Darwin's theory. They seem to suppose him to have held that Man was descended from one of the living Apes. This, of course, is not so. Man is not descended from a Gorilla or an Orang-utang, but, Man, the Gorilla, the Orang-utang and other Anthropoid Apes are all descended from some far away ancestor.

"A Pliocene Homo skeleton," Huxley said, "might analogically be expected to differ no more from that of modern men than the *Œningen canis* from modern Canes, or Pliocene horses from modern horses. If so, he would most undoubtedly be a man—genus Homo—even if you made him a distinct species. For my part, I should by no means be astonished to find the genus Homo represented in the Miocene, say, the Neanderthal man, with rather smaller brain capacity, longer arms, and more movable great toe, but at most specifically different."

In his work "On Man's Place in Nature," while referring to the other higher Quadrumana, Huxley dwelt principally on the chimpanzee and the gorilla, because, he said, "It is quite certain that the ape, which most nearly approaches man in the totality of its organisation, is either the chimpanzee or the gorilla."

This is no doubt the case at present; but the gibbons (Hylobates), while differing more in size, and modified in adaptation to their more skilful power of climbing, must also be considered, and, to judge from Prof. Dubois' remarkable discovery in Java of Pithecanthropus, which half the authorities have regarded as a small man, and half as a large gibbon, it is rather down to Hylobates than either the chimpanzee or the gorilla that we shall have to trace the point where the line of our far-away ancestors will meet that of any existing genus of monkeys.

Huxley emphasised the fact that monkeys differ from one another in bodily structure as much or more than they do from man.

We have Haeckel's authority for the statement that, "after Darwin had, in 1859, reconstructed this most important biological theory, and by his epoch-making theory of natural selection placed it on an entirely new foundation, Huxley was the first who extended it to man; and in 1863, in his celebrated three lectures on 'Man's Place in Nature,' admirably worked out its most important developments."

The work was so well and carefully done that it stood the test of time, and writing many years afterwards Huxley was able to say, and to say truly, that

"I was looking through 'Man's Place in Nature' the other day; I do not think there is a word I need delete, nor anything I need add except in confirmation and extension of the doctrine there laid down. That is great good fortune for a book thirty years old, and one that a very shrewd friend of mine implored me not to publish, as it would certainly ruin all my prospects" ("Life of Prof. Huxley," p. 344).

He has told us elsewhere ("Collected Essays," vii. p. xi.) that "it has achieved the fate which is the Euthanasia of a scientific work, of being inclosed among the rubble of the foundations of knowledge and forgotten." He has, however, himself saved it from the tomb, and built it into the walls of the temple of science, and it will still well repay the attention of the student.

For a poor man—I mean poor in money, as Huxley was all

his life—to publish such a book at that time was a bold step. But the prophecy with which he concluded the work is coming true.

"After passion and prejudice have died away," he said, "the same result will attend the teachings of the naturalist respecting that great Alps and Andes of the living world—Man. Our reverence for the nobility of manhood will not be lessened by the knowledge that man is, in substance and in structure, one with the brutes; for he alone possesses the marvellous endowments of intelligible and rational speech, whereby, in the secular period of his existence, he has slowly accumulated and organised the experience which is almost wholly lost with the cessation of every individual life in other animals; so that now he stands raised upon it as on a mountain top—far above the level of his humble fellows, and transfigured from his grosser nature by reflecting here and there a ray from the infinite source of truth" ("Collected Essays," vii. p. 155).

Another important research connected with the work of our Society was his investigation of the structure of the vertebrate skull. Owen had propounded a theory and worked it out most ingeniously that the skull was a complicated elaboration of the anterior part of the backbone; that it was gradually developed from a preconceived idea or archetype; that it was possible to make out a certain number of vertebræ, and even the separate parts of which they were composed.

Huxley maintained that the archetypal theory was erroneous; and that instead of being a modification of the anterior part of the primitive representative of the backbone, the skull is rather an independent growth around and in front of it. Subsequent investigations have strengthened this view, which was now generally accepted. This lecture marked an epoch in vertebrate morphology, and the views he enunciated still hold the field.

One of the most interesting parts of Huxley's work, and one specially connected with our Society, was his study of the ethnology of the British Isles. It has also an important practical and political application, because the absurd idea that ethnologically the inhabitants of our islands form three nations—the English, Scotch and Irish—has exercised a malignant effect on some of our statesmen, and is still not without influence on our politics. One of the strongest arguments put forward in favour of Home Rule used to be that the Irish were a "nation." In 1887 I attacked this view in some letters to the *Times*, subsequently published by Quaritch. Nothing is more certain than that there was not a Scot in Scotland till the seventh century; that the east of our island from John o' Groat's House to Kent is Teutonic; that the most important ethnological line, so far as there is one at all, is not the boundary between England and Scotland, but the north and south watershed which separates the East and West. In Ireland, again, the population is far from homogeneous. Huxley strongly supported the position I had taken up. "We have," he said, "as good evidence as can possibly be obtained on such subjects that the same elements have entered into the composition of the population in England, Scotland and Ireland; and that the ethnic differences between the three lie simply in the general and local proportions of these elements in each region. . . . The population of Cornwall and Devon has as much claim to the title of Celtic as that of Tipperary. . . . Undoubtedly there are four geographical regions, England, Scotland, Wales and Ireland, and the people who live in them call themselves and are called by others the English, Scotch, Welsh and Irish nations. It is also true that the inhabitants of the Isle of Man call themselves Manxmen, and are just as proud of their nationality as any other 'nationalities.'

. . . .

"But if we mean no more than this by 'nationality,' the term has no practical significance" ("The Races of the Brit. Isles," pp. 44, 45).

Surely it would be very desirable, especially when political arguments are based on the term, that we should come to some understanding as to what is meant by the word 'nation.' The English, Scotch and Irish live under one Flag, one Queen, and one Parliament. If they are not one nation, what are they? What term are we to use, and some term is obviously required, to express and combine all three. For my part I submit that the correct terminology is to speak of Celtic race or Teutonic race, of the Irish people or the Scotch people; but that the people of England, Scotland and Ireland, aye, and of the Colonies also, constitute one great nation.

As regards the races which have combined to form the nation, Huxley's view was that in Roman times the population of Britain comprised people of two types, the one fair, the other dark. The dark people resembled the Aquitani and the Iberians; the fair people were like the Belgic Gauls ("Essays," V. vii. p. 254). And he adds that "the only constituent stocks of that population, now, or at any other period about which we have evidence, are the dark whites, whom I have proposed to call "Melanochroi" and the fair whites or "Xanthochroi."

He concludes (1) "That the Melanochroi and the Xanthochroi are two separate races in the biological sense of the word race; (2) that they have had the same general distribution as at present from the earliest times of which any record exists on the continent of Europe; (3) that the population of the British Islands is derived from them, and from them only.

It will, however, be observed that we have (1) a dark race and a fair race; (2) a large race and a small race; and (3) a round-headed race and a broad-headed race. But some of the fair race were large, some small; some have round heads, some long heads; some of the dark race again had long heads, some round ones. In fact, the question seems to me more complicated than Huxley supposed. The Mongoloid race extend now from China to Lapland; but in Huxley's opinion they never penetrated much further West, and never reached our islands. "I am unable," he says, "to discover any ground for believing that a Lapp element has ever entered into the population of these islands." It is true that we have not, so far as I know, anything which amounts to proof. We know, however, that all the other animals which are associated with the Lapps once inhabited Great Britain. Was man the only exception? I think not, more especially when we find, not only the animals of Lapland, but tools and weapons identical with those of the Lapps. I must not enlarge on this, and perhaps I may have an opportunity of laying my views on the subject more fully before the Society; but I may be allowed to indicate my own conclusion, namely, that the races to which Huxley refers are amongst the latest arrivals in our islands; that England was peopled long before its separation from the mainland, and that after the English Channel was formed, successive hordes of invaders made their way across the sea, but as they brought no women, or but few, with them, they exterminated the men, or reduced them to slavery, and married the women. Thus through their mothers our countrymen retain the strain of previous races, and hence perhaps we differ so much from the populations across the silver streak.

Summing up this side of Huxley's work, Sir M. Foster has truly said that, "whatever bit of life he touched in his search, protozoan, polyp, mollusc, crustacean, fish, reptile, beast and man—and there were few living things he did not touch—he shed light on it, and left his mark. There is not one, or hardly one, of the many things which he has written which may not be read again to-day with pleasure and with profit, and, not once or twice only in such a reading, it will be felt that the progress of science has given to words written long ago a strength and meaning even greater than that which they seemed to have when first they were read."

In 1870, Huxley became a member of the first London School Board, and though his health compelled him to resign early in 1872, it would be difficult to exaggerate the value of the service he rendered to London and, indeed, to the country generally.

The education and discipline which he recommended were:—

(1) Physical training and drill.

(2) Household work or domestic economy, especially for girls.

(3) The elementary laws of conduct.

(4) Intellectual training, reading, writing and arithmetic, elementary science, music and drawing.

He maintained that "no boy or girl should leave school without possessing a grasp of the general character of science, and without having been disciplined more or less in the methods of all sciences."

As regards the higher education, he was a strong advocate for science and modern languages, though without wishing to drop the classics.

Some years ago, for an article on higher education, I consulted a good many of the highest authorities on the number of hours per week which in their judgment should be given to the principal subjects. Huxley, amongst others, kindly gave me his views. He suggested 10 hours for ancient languages and literature, 10 for modern languages and literature, 8 for arithmetic and mathematics, 8 for science, 2 for geography, and 2 for religious instruction.

For my own part I am firmly convinced that the amount of

time devoted to classics has entirely failed in its object. The mind is like the body—it requires change. Mutton is excellent food; but mutton for breakfast, mutton for lunch, and mutton for dinner would soon make any one hate the sight of mutton, and so Latin grammar before breakfast, Latin grammar before lunch, and Latin grammar before dinner is enough to make almost any one hate the sight of a classical author. Moreover, the classics, though an important part, are not the whole of education, and a classical scholar, however profound, if he knows no science, is but a half-educated man after all.

In fact, Huxley was no opponent of a classical education in the proper sense of the term, but he did protest against it in the sense in which it is usually employed, namely, as an education from which science is excluded, or represented only by a few random lectures.

He considered that specialisation should not begin till sixteen or seventeen. At present we begin in our Public School system to specialise at the very beginning, and to devote an overwhelming time to Latin and Greek, which, after all, the boys are not taught to speak. Huxley advocated the system adopted by the founders of the University of London, and maintained to the present day that no one should be given a degree who did not show some acquaintance with science and with at least one modern language.

"As for the so-called 'conflict of studies,'" he exclaims, "one might as well inquire which of the terms of a Rule of Three sum one ought to know in order to get a trustworthy result. Practical life is such a sum, in which your duty multiplied into your capacity, and divided by your circumstances, gives you the fourth term in the proportion, which is your deserts, with great accuracy" ("Life of Prof. Huxley," p. 406).

"That man," he said, "I think, has had a liberal education, who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of nature and the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of nature or of art, to hate all vileness and to respect others as himself."

He was also strongly of opinion that colleges should be places of research as well as of teaching.

"The modern university looks forward, and is a factory of new knowledge; its professors have to be at the top of the wave of progress. Research and criticism must be the breath of their nostrils; laboratory work the main business of the scientific student; books his main helpers.

Education has been advocated for many good reasons: by statesmen because all have votes, by Chambers of Commerce because ignorance makes bad workmen, by the clergy because it makes bad men, and all these are excellent reasons; but they may all be summed up in Huxley's words that "the masses should be educated because they are men and women with unlimited capacities of being, doing and suffering, and that it is as true now as ever it was that the people perish for lack of knowledge."

Huxley once complained to Tyndall, in joke, that the clergy seemed to let him say anything he liked, "while they attack me for a word or a phrase." But it was not always so.

Tyndall and I went, in the spring of 1874, to Naples to see an eruption of Vesuvius. At one side the edge of the crater shelved very gradually to the abyss, and, being anxious to obtain the best possible view, I went a little over the ridge. In the autumn Tyndall delivered his celebrated address to the British Association at Belfast. This was much admired, much read, but also much criticised, and one of the papers had an article on Huxley and Tyndall, praising Huxley very much at Tyndall's expense, and ending with this delightful little bit of bathos:—"In conclusion, we do not know that we can better illustrate Prof. Tyndall's foolish recklessness, and the wise, practical character of Prof. Huxley, than by mentioning the simple fact that last spring, at the very moment when Prof. Tyndall foolishly entered the crater of Vesuvius during an eruption, Prof. Huxley, on the contrary, took a seat on the London School Board."

Tyndall, however, returned from Naples with fresh life and health, while the strain of the School Board told considerably on Huxley's health.

Huxley's attitude on the School Board with reference to Bible teaching came as a surprise to those who did not know him well. He supported Mr. W. H. Smith's motion in its favour, which indeed was voted for by all the members except six, three of whom were the Roman Catholics, who did not vote either way.

"I have been," he said, "seriously perplexed to know by what practical measures the religious feeling, which is the essential basis of conduct, was to be kept up, in the present utterly chaotic state of opinion on these matters, without the use of the Bible. Take the Bible as a whole; make the severest deductions which fair criticism can dictate for shortcomings and positive errors; eliminate, as a sensible lay-teacher would do if left to himself, all that it is not desirable for children to occupy themselves with; and there still remains in this old literature a vast residuum of moral beauty and grandeur. And then consider the great historical fact that for three centuries this book has been woven into the life of all that is best and noblest in English history; that it has become the national epic of Britain, and is as familiar to noble and simple, from John o' Groat's House to Land's End, as Dante and Tasso were once to Italians; that it is written in the noblest and purest English, and abounds in exquisite beauties of mere literary form; and, finally, that it forbids the veriest hind who never left his village to be ignorant of the existence of other countries and other civilisations, and of a great past, stretching back to the furthest limits of the oldest nations in the world. By the study of what other book could children be so much humanised and made to feel that each figure in that vast historical procession fills, like themselves, but a momentary space in the interval between two eternities, and earns the blessings or the curses of all time, according to its effort to do good and hate evil, even as they also are earning their payment for their work?"

(*To be continued*).

THE NUMBERS OF THE AMERICAN BISON.

IT is eleven years since Mr. Hornaday published his interesting account of the extermination of the American Bison—a work that was fully noticed in these columns at the time. The author then estimated the number of living survivors of the species at 1091, of which 256 were in captivity and 835 running wild in British North America, the Yellowstone Park, and a few other localities. Recently Mr. Mark Sullivan has attempted to make a fresh census of the species, the results of which form the subject of a long article published in the *Boston Evening Transcript* of October 10.

As the result of his inquiries, Mr. Sullivan estimates the number of bison living at the present time as approximately 1024, of which 684 are in captivity and 340 running wild or half wild. His investigations appear to have been conducted with great care; and in the case of the greater number of domesticated herds—whether American or foreign—the numbers are practically accurate. The number of those running wild in the neighbourhood of the Great Slave Lake has, however, been arrived at by a process of "averaging;" and the extent of the herd in the Yellowstone is to a large degree a matter of guess-work. Another element of uncertainty is introduced by the alleged existence of wild bison in the mountains of Colorado; for while a Government official vouches for their occurrence in considerable numbers, old bison-hunters are very sceptical whether there are any at all. Admitting that the report of their existence in this district may be true, the author allows 21 as their conjectural number. He adds that reports of wild bison in other parts of the United States are pure fabrications.

The largest herd of pure-bred domesticated bison living in the United States is one belonging to the heirs of the late Mr. C. Allard, which ranges over the Flathead Indian Reserve in Montana, and numbers 259 head. Next to this comes the herd of Mr. Jones Goodnight, in Armstrong County, Texas, with a total of 110 head. The number living in countries other than America is given at 100, of which 26 are in England, the Duke of Bedford's herd of 12 at Woburn Abbey being probably the largest in this country.

Whatever may be the real number of wild bison, it is evident from the figures given above that they have decreased very seriously since 1887, while those living in captivity exhibit, on

the other hand, a very marked increase in numbers. Although the bison in the Yellowstone are protected so far as possible from poachers, many of them fall victims to beasts of prey, and their rate of increase seems to be slow. Those in British territory are much harried by Indians, and are consequently decreasing daily in number.

It is accordingly to the domesticated and semi-domesticated herds that we have to look for the maintenance of the species. And with the example of the Lithuanian herd of European bison before us, coupled with the larger size of several of the American herds, and the facilities that exist for the introduction of fresh blood to counteract the ill-effects of inbreeding, there would seem, at first sight, to be a great probability that the American bison may survive for many generations.

It has, however, been brought to the notice of the writer of the article under consideration that, in the case of animals living under conditions other than those which properly belong to them, there is a great tendency for the proportion of males among the offspring to increase in an alarming degree at the expense of the females. And to such an extent does this abnormality prevail in some of the herds, that in Bronx Park, New York, every calf is put down as a bull as a matter of course. If this were universal, the fate of the species would evidently be soon sealed; but fortunately it is not so, and as the Allard herd wanders almost at will under what are practically the natural conditions of the species, there still appears (in spite of certain disabilities) hope that the final extinction of *Bos bison* is a remote contingency. R. L.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. A. J. Evans, Keeper of the Ashmolean Museum, will give three public lectures on "The Palace of Knossos: its Art Treasures and Clay Archives," explanatory of his recent work in Crete; the dates announced are November 22, November 29, December 6.

The trustees of the Craven Fellowships have made a grant of 200*l*. to assist Messrs. Grenfell and Hunt in their Egyptian researches.

On Thursday, November 15, the new degree of Doctor of Letters was conferred upon Mr. B. P. Grenfell, Mr. A. S. Hunt, and Mr. J. Rhys, Principal of Jesus College, and the degree of Doctor of Science upon Prof. A. E. H. Love and Mr. H. W. Lloyd Tanner.

Prof. Miers has been appointed a delegate for the inspection and examination of schools.

The report of the Delegacy for the Training of Teachers states that there were twenty-six students on the books of the College at the end of the academical year. Mr. Roscoe, having been appointed Lecturer on Education in the University of Birmingham, has been succeeded by Mr. A. W. Priestley as Master of Method at the Day Training College.

CAMBRIDGE.—The syndicate appointed to superintend the erection of the Hopkinson wing of the engineering laboratory report that the work has been successfully caried out at a cost of 5516*l*. Of this, Mrs. Hopkinson and her family contributed 5000*l*. Additional donations, amounting to 1700*l*., have been received for the furnishing and equipment of the building, which have thus been carried out without expense to the University. The classes, however, are still growing rapidly, and the accommodation is already insufficient. A further extension will soon have to be undertaken, and new workshops are much needed.

The Medical School Syndicate propose that the existing Museum of Surgery and Pathology, which has become so infected with dry-rot that it endangers the contiguous structures, shall be demolished, and that the new Humphry Museum shall be erected on its site at a cost of some 8000*l*. Over 1000*l*. has been specially contributed for this memorial to the late Sir George Humphry, and it is hoped that if the work is actually begun other donations to the building fund may be received.

THE *British Medical Journal* states that under the will of the late Dr. D. J. Leech, professor of materia medica and therapeutics in the Owens College, Manchester, that college will eventually benefit to the extent of 10,000*l*., which Dr. Leech bequeathed for the purpose of endowing a chair of materia medica and therapeutics. The bequest will take effect upon the demise of Mrs. Leech.

LORD ROSEBERY dealt with many Imperial questions in his Rectorial address at Glasgow University on Friday last, but none were of more importance than those concerned with the factors of industrial progress, and their educational relationships. The following extracts from the *Times* report of his speech are of particular interest to all who are engaged in the work of science or scientific education:—The United States Consul at Chemnitz has remarked that, "If an industry in Germany languishes, immediately a commission inquires into the causes and recommends remedial measures, among which usually is the advice to establish technical or industrial schools, devoted to the branch of business under consideration." In a word, they go to the root, to the principle, to the source. This is thoroughness, this is the scientific method applied to manufacture, and we see its success. The Americans, I gather, have hitherto applied themselves rather less to the principles than the applications of science. I do not pretend to say which are right. The Germans are alarmed at the development of American commerce, and we are alarmed at both. At any rate, both in Germany and the United States you see an expenditure and a systematic devotion to commercial, and technical, and scientific training. I know that much is done, too, in Great Britain. But I doubt if even that is carried out in the same methodical way; nor is there anything like the same lavish, though well-considered, expenditure. It always seems to me as if in Germany nothing, and in Britain everything, is left to chance.

For the practical purposes of the present day, said Lord Rosebery at Glasgow, a University which starts in the twentieth century has a great superiority over a University founded in the fifteenth, more especially when it is launched with keen intelligence of direction and ample funds, as is the new University of Birmingham. These practical Universities are the Universities of the future; for the average man, who has to work for his livelihood, cannot superadd the learning of the dead to the educational requirements of his life and his profession. There will always be Universities, or, at any rate, colleges, for the scholar, the teacher, and the divine; but year by year the ancient Universities will have to adapt themselves more and more to modern exigencies. There was a time, long years ago, when the spheres of action and of learning were separate and distinct, when laymen dealt hard blows and left letters to the priesthood. That was to some extent the case when our oldest Universities were founded. But the separation daily narrows, if it has not already disappeared. It has been said that the true University of our days is a collection of books. What if a future philosopher shall say that the best University is a workshop? And yet the latter definition bids fair to be the sounder of the two. The training of our schools and colleges must daily become more and more the training for action, for practical purpose. Are there not thousands of lads to-day plodding away, or supposed to be plodding away, at the ancient classics who will never make anything of those classics, and who, at the first possible moment, will cast them into space, never to reopen them? Think of the wasted time that that implies; not all wasted, perhaps, for something may have been gained in power of application, but entirely wasted so far as available knowledge is concerned. And if you consider, as you will have to consider in the stress of competition, that the time and energy of her citizens is part of the capital of the commonwealth, all those wasted years represent a dead loss to the Empire. If, then, these recent events and the present conditions of the world induce thinkers and leaders in this country to test our strength and methods for the great struggle before us, they must reckon the training of man. On that, under Providence, depends the future, and the immediate future, of the race; and what is Empire but the predominance of race?

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, November 1.—Prof. S. H. Vines, F.R.S., President, in the chair.—Mr. J. E. Harting exhibited and made remarks upon the following birds which had been recently forwarded to him for examination:—(1) A hybrid between blackcock and red grouse, shot at Brechin, N.B., September 14. (2) A glossy ibis, killed at Saltash, Devon, October 4. (3) A little owl, obtained at Dunmow, Essex, October 22. Mr. F. D. Godman concurred in identifying the game-bird as a hybrid

between the species named, and considered such hybrids of rare occurrence, while examples of a cross between blackcock and pheasant were not nearly so uncommon. Mr. Howard Saunders regarded the little owl (*Carine noctua*) as having little if any claim to be considered a British bird; its occasional appearance in England being due to the fact that a good many had been turned out from time to time in different counties.—Mr. George Massee exhibited a series of coloured drawings and an extensive collection of fungi.—Dr. Charles Chilton, M.A., F.L.S., read a paper on the terrestrial isopods of New Zealand.—M. J. E S. Moore read a paper on the character and origin of the "park-lands" in Central Africa. These park-lands in the Tanganyika district have quite the appearance of having been formed by the hand of man, but are really natural growths, due to the fact that light surface-soil has been laid down over what appear to have been lake-deposits. Any given line of country will show large plantations, with quite a home-like look, separated by grass-lands; and, as Tanganyika is approached, they dwindle in size till they consist of a few shrubs, overshadowed by giant euphorbias, cactus-like in appearance. Then come stretches of grass, dotted with euphorbias, and, last of all, the salt steppes by the lake, which is now held to have had at one time an outlet to the sea. Mr. Moore's explanation is that at first only the euphorbias would grow on the salt steppes; but as these sprang up they afforded a shade and shelter to self-sown shrubs, each of which, as it established a footing, contributed to the natural planting of the area by the distribution of its seeds, till this process reached its highest development in the large plantations where the shrubs overtopped the euphorbias to which they owed their growth.

Geological Society, November 7.—J. J. H. Teall, F.R.S., President, in the chair.—Additional notes on the drifts of the Baltic coast of Germany, by Prof. T. G. Bonney, F.R.S., and the Rev. E. Hill. The authors, prior to revisiting Rügen, examined sections of the drift to the west of Warnemünde, with a view of comparing it with that of the Cromer coast. The authors give reasons to show that neither solution of the chalk, nor ice-thrust, nor folding, nor even faulting, can satisfactorily explain the peculiar relations of the drift and chalk in Rügen; and they can find no better explanation than that offered in their previous paper.—On certain altered rocks from near Bastogne and their relations to others in the district, by Dr. Catherine A. Raisin. Prof. Renard, from the petrographical study of specimens, and Prof. Gosselet, after description of the district and its stratigraphy, have attributed the changes in these rocks to mechanical disturbances. Dumont had previously described many examples, and inclined to the view of contact-alteration, which was favoured by Von Lasaulx's discovery of a granite in the Hohe Venn, and M. Dupont's identification of chiastolite from Libramont. The present paper treats especially of the garnetiferous and hornblendic rocks, giving the full petrographical and field-details of a few examples. It points out that the effects of pressure are evident over the whole district, while mineral modifications resembling the results of slight contact-action are found in certain areas. In a few cases these modifications are more marked, and sometimes increase as we approach veins composed of quartz, felspar and mica, such as might be connected with a concealed granite. The peculiar garnetiferous and hornblendic rocks, although occurring within the zone of alteration, are extremely limited, often forming patches or bands a few feet across. They differ, as described in the paper, from ordinary contact-altered rocks. The evidence, in the authoress's opinion, is in favour of Prof. Bonney's suggestion that they are due to some form of hot-spring action.

Entomological Society, November 7.—Mr. G. H. Verrall, President, in the chair.—Mr. G. S. Saunders exhibited specimens, from Devonshire, of *Pieris rapae* and *Plusia gamma*, caught by the proboscis in flowers of *Araujia albens*, Don., a climbling plant of the natural order *Asclepiadaceae*; and explained the nature of the mechanism by which the insects were entrapped by the flowers. He also showed specimens of the "bedeguar" gall formed apparently on the "hips," or fruit, of *Rosa canina*. Mr. Gahan remarked that the capture of insects by the plant named had recently been investigated in France by MM. Marchand and Bonjour, whose account appeared in the *Bulletin* de la Soc. des Sciences Nat. de l'Ouest de la France, for 1899. These authors concluded that insects were captured only by immature flowers, the anther-wings, in the cleft between which the proboscis of the insect is caught, being at that time stiff and resistant; but when the flowers are ripe the anther-wings become less rigid and do not offer sufficient resistance to the withdrawal of the proboscis, which carries with it the pollinia ready to be transferred to the stigma of the next flower visited by the insect.—Mr. W. J. Kaye exhibited *Hydrocampa stagnalis*, var., with examples of the typical form for comparison; the variety differed in having the basal line nearly obsolete, the sub-median double line much strengthened internally and reduced externally, and the cross band connecting the sub-median and post-median bands almost entirely obliterated.—Mr. F. Merrifield exhibited a variety of *Argynnis dia* taken with a few examples of the ordinary form at Ilanz in the Vorder Rhein valley early in September last, when what was, he believed, a third brood of this species, was abundant; the variety was much blackened on the basal half of all the wings.—Canon Fowler exhibited a specimen of *Orochares angustatus*, Erichs., a Staphylinid beetle new to the British list, taken at Leverstock Green, Herts, by Mr. Albert Piffard.—The Rev. F. D. Morice mentioned, as a fact of some interest, that in a nest of *Formica sanguinea* at Weybridge, in which he found males and workers of that species, he found also males and females as well as workers of the slave-ant *Formica fusca*, an experience somewhat different to that of Huber and Darwin, who stated that workers only of the slave species were found in the nests of *sanguinea*.—The Secretary read "Some notes on variations of *Zeritis thysbe*, Linn.," communicated by Mr. H. L. L. Feltham, and exhibited one female and two male specimens of one of the rare forms referred to in the paper.

Mathematical Society, Nov. 8.—Lord Kelvin, G.C.V.O., President, in the chair.—Reports from the Treasurer and Secretaries were read and received. The ballot was taken and the gentlemen whose names appeared in NATURE for October 18 were declared to have been duly elected to serve on the Council for the session 1900–1901. Lord Kelvin, on leaving the chair, thanked the Society for having elected him to the office, and regretted that the distance (400 miles) of his home from town had caused him to be so rarely able to take the chair. He then cordially welcomed his successor, Dr. Hobson, and expressed his pleasure in having him for his successor. The new President thanked the members for electing him, and then called upon Lord Kelvin to deliver his address "On the transmission of force through a solid." The address was a very interesting one, and on the motion of Dr. Glaisher, seconded by Dr. Larmor and backed by the acclamation of the members present, Lord Kelvin consented to put his remarks into a shape fitted for publication in the Society's *Proceedings*.—Dr. Glaisher then communicated two papers: (i) A general congruence theorem relating to the Bernoullian function; (ii) On the residues of Bernoullian functions for a prime modulus, including as special cases the residues of the Eulerian numbers and the I-numbers.—Mr. Tucker next communicated some notes on Isoscelians, and gave a few properties of two in-triangles similar to the pedal triangle. These triangles have their sides perpendicular to the antiparallels of the primitive triangle.—The President communicated the remaining papers by simply reading their titles. In a simple group of an odd composite order every system of conjugate operators or subgroups includes more than fifty, Dr. G. A. Miller.—Prime functions on a Riemann surface, Prof. A. C. Dixon.—On Green's function for a circular disc, H. S. Carslaw.—On the real points of inflection of a curve, A. B. Basset.—On quantitative substitutional analysis, A. Young.—On a class of plane curves, J. H. Grace.—(i) On group characteristics, and (ii) On some properties of groups of odd order, Prof. W. Burnside.—(i) Conformal space transformations, and (ii) Dynamical and other applications of algebra of bilinear forms, T. J. Bromwich.

Mineralogical Society, November 13.—Prof. A. H. Church, F.R.S., President, in the chair.—Mr. G. F. Herbert Smith described an improved form of his three-circle goniometer, in which the use of an autocollimating telescope obviates the disadvantage of the original instrument that measurements could only be made through 93°.—Mr. Harold Hilton gave a simple proof of the rationality of the anharmonic ratio of four faces of a zone.—Mr. R. H. Solly, in continuation of the investigation of sulpharsenites of lead from the Binnenthal, described the crystallographic characters of rathite.

MANCHESTER.

Literary and Philosophical Society, October 30.—Prof. Horace Lamb, F.R.S., President, in the chair.—A paper on the solubility of certain lead glasses or fritts used in the preparation

of pottery glazes, by William Jackson and Edmond M. Rich, was read. The paper described experiments carried out to determine what factors, apart from chemical composition, affect the amount of lead oxide yielded to dilute hydrochloric acid by lead fritts as used by potters. It was found that the solubility is increased in a very marked manner by increase of fineness, so that it appears that if details are given of the solubility of fritts they should be accompanied by particulars of its degree of fineness. The solubility of the same fritt reduced to different degrees of fineness varied from 1 to 15 per cent. of the material used. It was found also that after the action of the acid has proceeded for a short time it appears that the whole of the soluble lead has been extracted. This, however, was due, not to the absolute insolubility of the remainder, but to the formation of an insoluble layer on the surfaces exposed to the action of acid which protects the particles from further action. By removing this layer by chemical or physical means it was found possible to extract more lead oxide from the fritt, and by continually removing this insoluble layer it was possible to extract continually more lead oxide, until practically the whole of the lead oxide passed into solution.—A paper on the phloem of *Lepidophloios* and *Lepidodendron* was read by Prof. F. E. Weiss. The author had examined sections of these two nearly allied fossil plants in which the tissues have been exceptionally well preserved. The examination of these specimens led him to the conclusion that the phloem region is not occupied by large secretory sacs, and that the tissue is not partially disorganised during the life of the plant, as has been suggested, but that it consists of cells not fundamentally different from those composing the phloem of living lycopods. In those stems, however, in which secondary thickening is found to have taken place, an active division of some of the phloem cells can be observed. The author discussed the possible reasons for the usual destruction of the phloem elements, and considered that it must take place previous to mineralisation, but after the death of the plant. He attributed the more ready destruction of the phloem cells to the peculiar nature of the cell walls, which he thought were probably composed—as in the case of the nearly allied lycopods—of amyloid, a semihydrate of cellulose. This substance is more easily acted upon by water than cellulose, and consequently the phloem would be more liable to rapid decay than the rest of the tissues.

November 13.—Prof. Horace Lamb, F.R.S., President, in the chair.—Prof. Reynolds mentioned a curious phenomenon observed at sunset during the summer, in the form of a narrow beam of light proceeding vertically from the sun and persisting for about half an hour after sunset. A similar appearance was seen by Mr. Thorp when crossing the Mediterranean in the early summer.—Dr. Lees called attention to a useful expression for calculating the circumference of an ellipse to a close degree of approximation, more simple than those ordinarily given in engineers' text-books.—Mr. Thorp described a method by which he had succeeded in silvering his diffraction films, and he referred to a device by which he expects to obtain similar films from concave surfaces.—Prof. Dixon discussed the reversal of lines of the spectrum of an explosion wave observed by Profs. Dewar and Liveing, and gave an alternative explanation to that offered by them. He also discussed Mendeléeff's theory as to the nature of the action which takes place when hydrogen and oxygen or other pairs of gases combine, and suggested an alternative view of the nature of the reaction.

EDINBURGH.

Royal Society, November 5.—Sir Arthur Mitchell, Vice-President, in the Chair.—As usual at the first meeting of the session, the chairman gave a short review of the work of the preceding session. In particular, attention was drawn to the bequest to the Society made by the late Prof. Piazzi Smythe; to the representation which the Society had made to the Geological Survey Committee as to the advisability of completing the survey of Scotland on the six-inch scale; and to the Scottish Antarctic Expedition now being organised by Mr. W. S. Bruce.—A paper was read by Drs. O. Noel Paton, J. C. Dunlop and Elsie Inglis on dietary studies of the poorer classes in Edinburgh. The diets of fifteen families, including ninety-five individuals belonging to the labouring classes, were studied by the method employed by Atwater in America. It was found that the average diet of the thrifty poor contained 108 grms. of proteid and 3275 large calories of energy per man per diem; but among the thriftless and ignorant very defective diets were observed. Such a deficient diet cost, for an average family of father, mother and four or five children, about 15*s*. 6*d*. per week, which leaves out of a labourer's wage of 20*s*. to 22*s*. a sum too small for the other necessaries of life and nothing for recreation.—In a note on the relations amongst the thermo- and electro-magnetic effects, Dr. W. Peddie showed how the Hall, the Nernst, the Ettingshausen and the Leduc effects may be represented in mutual relation, so that when, say, the Leduc effect is known, the others may be predicted. For this purpose consideration is taken of the direction of the resultant heat flow induced in consequence of the changes of temperature gradient evidenced in the Thomson effect. The Leduc effect is known only in the case of bismuth, yet, in the case of other metals, the possible signs of the remaining effects can be deduced; and the actual signs are found to be included in these in all cases except those of cobalt and zinc.

Mathematical Society, Nov. 9.—Mr. R. F. Muirhead in the chair.—The following papers were read: Euclidian proof of Pascal's theorem, by Mr. R. F. Davis.—Note on the expression for the area of a triangle, by Mr. C. Tweedie.—Proof of a theorem in co-ordinate geometry, by Mr. J. Jack (communicated by Mr. A. Milne).—The following were elected office-bearers for the current session: President, J. W. Butters; Vice-President, Geo. Duthie; Hon. Secretary, D. C. McIntosh; Hon. Treasurer, James Archibald.

PARIS.

Academy of Sciences, November 12.—M. Maurice Lévy in the chair.—On the next appearance of the Leonids, and their aërostatic observation, by M. J. Janssen. In order to prevent the interference of clouds with the observations of the Leonids, arrangements had been made for a balloon ascent on each of the three nights, November 13–14, 14–15, and 15–16, during which Leonids may be expected.—On the conditions affecting chemical activity under the action of silent electrical discharges, by M. Berthelot. The effects of silent electrical discharges ("effluve") and of atmospheric electricity are compared, the production of oxides of nitrogen, ozone and nitric acid being possible in this way without actual lightning. Some of the effects produced in Deville's hot and cold tube experiments, and ascribed by him to dissociation, are also ascribed by the author to similar electrical effects.—On the order of formation of the elements of the central cylinder in the root and stem, by M. Gaston Bonnier. The central cylinder presents the sam general structure in both root and stem, the constitution and the order of development of the tissues being the same in both cases, except as regards the position of the ligneous poles. The paper is illustrated by six diagrams showing sections of *Thalictrum silvaticum*, *Chenopodium polyspermum*, *Ricinus communis*, *Pulmonaria officinalis* and *Ranunculus acris*.—The Perpetual Secretary announced to the Academy the death of M. l'Abbé Armand David, Correspondent for the Section of Geography and Navigation.—On surfaces which possess a non-linear series of rational curves, by M. S. Kantor.—On the series analogous to Lagrange's series, by M. A. Bougaïev.—Superficial lines appearing in the sawing of metals, by M. Ch. Frémont. Six photographs are given of sections of different shapes cut by sawing. A series of lines, differing from the saw markings, are produced, which vary with the shape of the piece cut, the systems of lines being parallel to the edges cut by the saw. They differ from Lüder's lines.—On the experiments of Prof. Rowland relating to the magnetic effect of "electrical convection," by M. V. Crémieu. In previous communications the author has described experiments which led him to the conclusion that the so-called "electrical convection" produced no magnetic effect. Further experiments are now described, corresponding exactly to those of Rowland and of Himstedt, in which a charged disc rotates round a magnetised needle. In the first experiment no deviation of the needle was observed, although the effect should have been from 12 to 175 mm. In other experiments a deviation was obtained, but it is shown that these deviations are not due to the magnetic effect of the electrical convection, since they can be suppressed by the intervention of a metallic plate. The whole work tends to show that, contrary to the experiments of Rowland, electrical convection produces no magnetic effect.—On the splitting-up by alkalis of acetylenic ketones, by MM. Ch. Moureu and R. Delange. Ketones of the type $R-C\equiv C-CO.R'$ are split up by heating with alkalis. An acid and a ketone would, in general, appear to be produced simultaneously, thus benzoylphenylacetylene, $C_6H_5.C{:}C.CO.C_6H_5$, gives benzoic acid and acetophenone.

Acetylphenylacetylene behaves in an exceptional manner, giving phenylacetylene and acetic acid.—On the constitution of camphoric acid and the migrations which occur within its molecules, by M. G. Blanc.—On the evolution of terpene derivatives in the geranium, by M. Eug. Charabot. Acidity diminishes as the plant grows, and the amount of ester increases, possibly at the expense of the geraniol. The ketonic compounds occur chiefly at the time when the plant possesses the maximum respiratory activity.—On the presence of invertine or sucrase in grapes, by M. V. Martinand.—The old course of the Aar, near Meiringen (Switzerland), by M. Maurice Luglon.—On the regeneration of confined air by means of sodium peroxide, by MM. Desgrez and Balthazard. A reclamation of priority against H. G. F. Jaubert.

NEW SOUTH WALES.

Linnean Society, September 26.—The Hon. James Norton, President, in the chair.—Phosphorescent fungi in Australia, by D. McAlpine. Phosphorescent fungi are generally natives of warm climates, and the largest number of Agarics possessing this property, for any locality, has been met with in Australia. Out of twenty-one species known altogether, fifteen occur in Australia, while five of them are confined to the Island Continent. *Pleurotus candescens*, F.v.M., is very common in the neighbourhood of Melbourne during April and May, and was specially studied in connection with the phenomenon of phosphorescence or luminosity. Luminosity was practically confined to the gills, which were found to be decidedly acid. The light probably proceeded from excreted luminous metabolic products known as phosphorescents.—On a new genus and two new species of Australian *Coccidae*, by E. Ernest Green. A species of *Rhizococcus* from *Acacia decurrens* at Mittagong, N.S.W., and one of *Antecerococcus* (gen. nov.) from *Pittosporum eugenioides*, at Bathurst, N.S.W., are described.—Observations on the tertiary flora of Australia, with special reference to Ettingshausen's theory of the tertiary cosmopolitan flora, Part ii., by Henry Deane. The aspect of the subject particularly considered in this paper is the venation of leaves and its untrustworthiness in the determination of botanical affinities. Plants cannot be classified by their leaves, as their form and venation do not in any way correspond to the acknowledged botanical divisions. It is found that the same types occur in widely different orders and different types in the same genus. As to variability of types in the same genus, examples from the genera *Quercus* and *Eucalyptus* were given; and illustrations of closely similar and even undistinguishable leaves of distinct genera and orders were mentioned.—Notes on the botany of the interior of New South Wales, Part i., by R. H. Cambage. This first instalment is descriptive of the characteristics, distribution and relation to geological formation, of the more conspicuous members of the flora, such as the Eucalypts, Acacias, &c., noticeable between Bourke and Cobar, a distance of about 100 miles.—A fish disease from George's River, by R. Greig Smith. Under the proposed name of *Vibrio bresmiae* an organism is described which was isolated from the carcass of a fish found dying under suspicious circumstances in George's River. The organism is pathogenic to fish, producing death in about two days. It is non-phosphorescent, but is otherwise closely allied to this group of vibrions.—Australian land planarians: descriptions of new species, and notes on collecting and preserving, No. ii., by Thos. Steel. Three new species of *Geoplana* from Western Australia are described, and the occurrence of a new variety of *G. quinquelineata*, F. and H., is noted. These are of interest as being the first land planarians recorded from this part of Australia. The same new variety of *G. quinquelineata* is also recorded from South Australia, and a description of it is given. Another *Geoplana* found in the vicinity of Sydney is described as new.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 22.

ROYAL SOCIETY, at 4.30.—Further Note on the Spectrum of Silicium: Sir Norman Lockyer, K.C.B., F.R.S.—On Solar Changes of Temperature and Variations in Rainfall in the Region Surrounding the Indian Ocean: Sir Norman Lockyer, K.C.B., F.R.S., and Dr. W. J. S. Lockyer.—On the Restoration of Co-ordinated Movements after Nerve Crossing with Interchange of Function of the Cerebral Cortical Centres: Dr. R. Kennedy.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telegraphs and Telephones at the Paris Exhibition, 1900: John Gavey.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—On the Berbers of Algeria, and their Connections with Prehistoric Egypt: D. Randall-MacIver and A. Wilkin.

FRIDAY, NOVEMBER 23.

PHYSICAL SOCIETY, at 5.—An Automatic Wheatstone's Bridge: W. C. D. Whetham.—The Anomalous Dispersion of Carbon: Prof. R. W. Wood.—The Liquefaction of Hydrogen: Dr. M. W. Travers.—On the Refraction of Sound by Wind: Dr. E. H. Barton.

SATURDAY, NOVEMBER 24.

ESSEX FIELD CLUB (Museum of Natural History, Stratford), at 7.—On the Variations in the Marine Animals on Coast of Essex during the last Ten or Twelve Years: Dr. H. C. Sorby, F.R.S.—Notes on the Eocene Fauna and Flora of Walton-on-Naze: J. P. Johnson.—British Wild Flowers Photographed from Nature: J. C. Shenstone.

MONDAY, NOVEMBER 26.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Expedition to Lake Tanganyika and the Country to the North: J. E. S. Moore.

SOCIETY OF ARTS, at 8.—Electric Oscillations and Electric Waves: Prof J. A. Fleming, F.R.S.

INSTITUTE OF ACTUARIES.—Inaugural Address by the President, C. D Higham.

TUESDAY, NOVEMBER 27.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—On Stone Implements from Tasmania: J. Paxton Moir.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: The Metropolitan Terminus of the Great Central Railway: G. A. Hobson and E. Wragge.—*Paper to be read and discussed, time permitting*: Machinery for the Manufacture of Smokeless Powder: Oscar Guttmann.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Analytical Portraiture: Francis Galton, F.R.S.

WEDNESDAY, NOVEMBER 28.

SOCIETY OF ARTS, at 8.—Malaria and Mosquitoes: Major Ronald Ross.

THURSDAY, NOVEMBER 29.

GOLDSMITHS' INSTITUTE CHEMICAL SOCIETY, at 8.30.—The Profession of an Industrial Chemist: Dr. J. Lewkowitsch.

CONTENTS.

THURSDAY, NOVEMBER 29, 1900.

THREE BOOKS ON BIRDS.

The Birds of Ireland; an Account of the Distribution, Migration and Habits of Birds as Observed in Ireland, with all Additions to the Irish List. By R. J. Ussher and R. Warren. Pp. xxxii + 419. Illustrated. (London: Gurney and Jackson, 1900.)

The Story of the Birds. By C. Dixon. Pp. xiv + 304. (London: George Allen, 1900.)

Among the Birds. By Florence Anna Fulcher. Pp. iii + 253. (London: S.P.C.K, 1900.)

IN a few months half a century will have elapsed since the publication of the third and concluding volume of Thompson's "Birds of Ireland," and, with the exception of a smaller volume written on more popular lines, and the valuable "List of Irish Birds" (two editions of which have appeared), by the late Mr. A. G. More, of Dublin, no other complete treatise on the same subject has hitherto been issued. With the great advances in our information on this special subject, and the improvements in our method of treating natural history in general, to say nothing of the changes which have occurred in the Irish avifauna itself during that long interval, it will be evident that there is abundant room for an authentic and standard work of the nature of the one before us. And no one could have been found better fitted to undertake this important and laborious task than Mr. R. J. Ussher, who has written the bulk of the present volume, and who has devoted the greater part of his life to the study of the history and habits of his well-beloved Irish birds. As regards the contributions of Mr. R. Warren, whose name appears on the title-page as joint-author, we are told in the preface that the portions of the work actually from his own pen are restricted to the accounts of half-a-dozen species. Mr. Ussher is, however, careful to acknowledge his indebtedness to his friend and coadjutor for a number of observations on the habits and distribution of birds. And he likewise declares his obligations to the late Mr. More, and also to Mr. R. M. Barrington, who has contributed much information with regard to bird-migration, drawn from the observations taken at the lighthouse stations.

Mr. Ussher appears, indeed, to have carried out his task in a thoroughly satisfactory and conscientious manner; and has succeeded not only in producing an accurate and trustworthy treatise on Irish birds, but likewise a readable and interesting book. With the many illustrated works extant at the present day on British birds, it would have been merely a useless expense to have repeated figures of the species found in Ireland; and a wise discretion has, we venture to think, been exercised in limiting the illustrations (which can scarcely be surpassed for excellence) to photographs of the nests of birds and of the breeding haunts of some of the maritime species. An exquisite coloured plate of six distinct colour-phases of Irish peregrine falcon eggs forms an appropriate frontispiece.

A feature of the work is the special attention bestowed on the local distribution of birds within the area treated of; this being elaborated in a series of tables which alone serve to indicate the enormous amount of labour bestowed by Mr. Ussher on his subject. In formulating these tables, he owns himself greatly indebted to correspondents from all parts of the country, who have filled up schedules sent to them for the purpose of recording their observations. So far as our recollection serves us, similar tables have not been issued with any work on the birds of Britain generally; and, in view of the present trend of natural history studies, the importance of those drawn by Mr. Ussher can scarcely be over-estimated.

In regard to classification and nomenclature, Mr. Ussher follows Mr. Saunders, in his "Manual of British Birds," and since, in our opinion, uniformity is of more importance than anything else in classification, we think he has been well advised in so doing. With the exception of the red grouse, he apparently regards no species of bird as peculiar to the British Islands; neither are any local Irish races admitted. In regard to the British marsh-tit, which Dr. Sharpe considers entitled to rank as a species apart from the continental form, under the name of *Parus dresseri*, Mr. Ussher admits no such distinction. Curiously enough, however, the subspecific title *Parus palustris dresseri* occurs in the index, but on turning to the page (31) quoted, only the name *P. palustris* is to be found. It may also be noted that on p. 230 the author refers to the generally lighter colour of Irish red grouse as compared with their relatives in Great Britain; and if this be a constant point of distinction, it would justify, in the opinion of many naturalists, the separation of the former as a local race.

It may be noticed that in the preceding paragraph we have employed the word "apparently" in regard to the absence of peculiar British species and races. We have done so because we have not been at the pains to look at the heading under which each particular bird is described, and there is no table of contents to the book in which it could be seen at a glance whether or no the above statement is absolutely correct. The omission of such a table is, we think, a decided disadvantage to the book. Its presence would likewise have told us the number of species of birds regarded by Mr. Ussher as entitled to be called Irish; but, as he does not number his species, this also can only be ascertained by going through the book page by page.

Not that this question of the number of species is one of much importance one way or the other, for, as the author tells us, it is always difficult to draw lines in cases of this nature. On the whole, however, we think that a wise discretion has been exercised in this particular instance, the species whose claims to admission rest on the slenderest foundations being treated by themselves. Apart from its fossilised bones, the only historic evidence in modern times for regarding the great auk as an Irish bird is furnished by the example captured near Waterford Harbour in 1834; and consequently the account of this species might with advantage have been considerably curtailed, as almost more than enough has been written about it in other works.

Occupying the most western position of the islands of the British group, and enjoying a singularly equable and mild climate, Ireland naturally cannot lay claim to the possession of nearly so many species of birds as are found within the limits of Great Britain. This deficiency

in species is, however, in some degree compensated by the great numerical abundance of certain of these in individuals, many of the coast cliffs, with their adjacent islands, being frequented during the breeding season by vast flocks of gannets, gulls, auks, puffins, guillemots, petrels, &c.

In regard to the eggs of guillemots, it may be mentioned that Mr. Ussher makes two interesting observations. In the first place, he says that the beautiful varieties of colouring, which are so characteristic of the eggs of this species, "must help each bird to distinguish her egg from others lying near, until they all become stained and soiled." In another passage he observes that the eggs "get completely covered in filth as incubation proceeds, and I have seen many cemented thereby to the rock. This may account for the exaggerated statement that the bird has the power of gluing them to the rock to prevent them from falling off."

In connection with the uniform climate of Ireland, to which reference has already been made, it may be observed that climatic conditions can scarcely explain all the features in the distribution of birds; this being remarkably exemplified by the circumstances that while the red-breasted merganser has an extensive breeding range in Ireland, yet that elsewhere in the British Islands its breeding is restricted to Scotland.

In regard to "station," Ireland, as most of our readers are doubtless well aware, possesses a variety which renders it peculiarly adapted to an abundant development of bird life. These variations are excellently well displayed in a map, in which the uncultivated areas are tinted brown. *Primâ facie*, it might have been thought that all the moors and bogs of Ireland were equally well suited to maintain a large bird population. But this, according to Mr. Ussher, is by no means the case, most of the western moors being comparatively destitute of life. The reason for this we should like to see explained.

Many birds now rare in England are comparatively common in Ireland, among them being the raven and the chough. Of the former Mr. Ussher writes that "in the west it still breeds undisturbed on the Arran Islands, High Island, and the Twelve Pins of Connemara, while the cliffs of Mayo and of Achil Island are among its chief strongholds." We presume there is no danger to the bird in the mention of these localities, as otherwise the author would not have done so, since he states, on page 374, that the disclosure of the nesting haunts of the red-throated diver led to its extermination as a breeding Irish species.

While Ireland has lost certain members of its original fauna, such as the great auk, the crane and the capercaillie, it has gained others by apparently natural causes. Among these latter are the missel-thrush and the magpie, both of which have now thoroughly well established themselves. Sportsmen will be pleased to learn that woodcock are yearly becoming more numerous during the summer in Irish coverts. And although it was feared some years ago that the quail was about to forsake the country for ever, its reappearance in some numbers during 1892–93 affords hope that it may some day be reestablished. All efforts to introduce the blackcock and the ptarmigan have, however, resulted in signal failure, and Mr. Ussher refuses to admit certain evidence derived from cavern bones as to their former existence in the island.

In conclusion, we cannot but repeat our sense of the high value and importance of Mr. Ussher's work, which must long remain the standard authority on the subject of which it treats. Errors and misprints are few and far between, and most of them have been detected and corrected by the author. The book is thoroughly well turned out, and should have a place on the bookshelves, not only of every British ornithologist, but of every sportsman who visits Ireland.

Of a very different character from the above is the book standing second on our list, which appeals only to the amateur ornithologist. Mr. Dixon and his publishers seem, indeed, to be under the impression that the British public has an unlimited appetite for popular bird-books, and to supply this an endless stream of works is poured from this author's pen. In the present volume Mr. Dixon takes a new departure, and tries to interest his readers in the anatomy and general structure of birds, as well as in their geographical distribution, both past and present.

Although a compilation, in which the author confesses himself much indebted to Prof. Newton's "Dictionary of Birds," the account of the palæontology and osteology is, on the whole, satisfactory. Perhaps, however, the statement on page 3, that reptiles are more nearly related to birds than to any other animals, might advantageously be modified in view of recent investigations into the structure of the anomodonts; and it is not true that all dinosaurs are gigantic. Exception may also be taken to the statement on page 13, that the tropical types of birds whose remains occur in the European tertiaries are necessarily of southern origin, the available evidence, for what it is worth, pointing to a precisely opposite conclusion. Neither do we think the idea mooted on page 105, "that some scheme of latitudinal division will yet be proved to be the correct one" for the division of the globe into zoo-geographical distribution is at all likely to find acceptation among those best qualified to deal with this subject.

In the osteological section, no indication is given that the so-called tibia of the bird (p. 35) includes a portion of the tarsus, or that the remaining part of that element is fused with the compound bone incorrectly called metatarsus.

After treating of their palæontology, structure, and distribution, Mr. Dixon takes into consideration their general habits and physiology, including flight, social instincts, food, mimicry and protective coloration, nuptial display, song, and nidification. All these subjects are treated in a manner calculated to attract the interest of the general reader. But there are some ugly sentences; as, for instance, the following on p. 29:—

"The first cervical vertebra is termed the atlas, because it bears the head, and which is articulated with it by a single occipital condyle."

And the work is not free from misprints, as witness (p. 115) *Merganettine* instead of *Merganettinae*. Nevertheless, the book, as a whole, is a creditable production; and it has the great merit of drawing attention to the fact that the scope of ornithology is not confined to the c lours and other external characters of birds.

Essentially popular and "gossipy" in its style, Miss Fulcher's "Among the Birds" is written by an enthusiastic bird-lover for other bird-lovers—whether young or old—who desire information on a fascinating subject without entering into zoological technicalities. As we learn from the preface, a number of the chapters have already appeared in various journals and magazines; and, in spite of the multitude of bird-books relating to the British Islands, they seem decidedly worthy of reproduction in permanent form. For the author has much of the fascination of style characteristic of "A Son of the Marshes," and writes mainly, if not entirely, from personal experiences of her feathered friends, her observations extending from the peaceful meadows and fields of Middlesex and Hertfordshire to the rugged moors and sea-cliffs of Scotland and the Farne Islands. Indeed, if the author has a fault, it is in a somewhat overweening confidence in her own opinions and theories, this being especially noticeable in the chapter on migration. And in this connection it may be mentioned that there are other English ornithologists besides Mr. C. Dixon who have written on the last-mentioned subject.

Personally we are of opinion that the author is at her best when describing birds in their actual haunts, the chapters on migration, nests, song and the "ministry of birds" being far less satisfactory than those dealing with the avifauna of particular stations. The chapters which strike us as being the most interesting are those entitled "The Tern Nursery on the Noxes," "Birds on the Wide Opens," "Guillemots on the Pinnacles," "Puffins" and "Birds of a Sea Marsh." In the second of these we have been particularly attracted by the description of the oyster-catcher. "Its form," writes the author, "is attractively odd and quaint as it rests heavily on its long and delicate pink legs. But the feature which distinguishes it from all British birds is the beak—the great staff of coral on which the bird seems to rest, when it stands with head bent, as a kangaroo rests on its tail—the great load of coral which seems to weight the bird's head so that it bows at every step it walks, and which it holds out like a herald's trumpet as it flies: two great mandibles of coral, thick and long, twice as long as the bird's head, and almost twice as thick as its long and slender legs. Why it requires such an implement is not quite clear." This, which is by no means a solitary instance, is distinctly original, and originality is a consummation much to be desired in natural history writings.

With the ways of the poacher the author displays considerable familiarity; and her statement of the manner in which illicitly killed grouse are preserved in Ireland till the 12th of August will probably be a revelation to many of our readers. She is perhaps unnecessarily severe on those who enjoy a dish of roast larks or a plover's egg; and, we believe, she decidedly over-estimates the fear of any serious diminution in the number of either lapwings or larks in this country. But all will be with the author in her endeavour to promote increased protection for birds in such cases as it may be demonstrated to be necessary.

In spite of the competition to which allusion has already been made, it may be hoped that lovers of birds will find a place in their bookcase for the present attractive little volume. R. L.

CHRONICA MATHEMATICA.

A Brief History of Mathematics. An authorised translation of Dr. Karl Fink's "Geschichte der Elementar-Mathematik." By W. W. Beman and D. E. Smith Pp. xii + 334. (London: Kegan Paul, Trench Trübner and Co., Ltd., 1900.)

THANKS, in great measure, to the unwearied industry and acumen of Dr. Moritz Cantor, it is now comparatively easy to construct a synopsis of mathematical history down to the beginning of the nineteenth century. It is true that success depends upon much more than a mere knack of précis-writing: the task requires judgment, discrimination and a certain kind of sympathy; still, the labour of such a work is greatly simplified now that the essential facts have been made accessible in Dr. Cantor's incomparable lectures. But when the historian loses the aid of this accomplished guide, and endeavours to carry on the tale down to our own time, he is at once met by serious difficulties, even if he confines himself to a strictly limited field. Most of the writers of popular histories of mathematics break down hopelessly when they reach the nineteenth century; they are hampered by the limitations of their own knowledge, and a consciousness of the difficulty of writing so as to be understood by the audience to whom they address themselves.

Prof. Fink, with rare and admirable courage, has disdained to shirk the problem, and has made a conscientious effort to trace the development of his subject down to the present day. The range of his work is limited to "elementary mathematics," that is to say, arithmetic, elementary geometry and algebra, and trigonometry; this has, of course, lightened his task considerably. But he has kept in view the connection of these subjects with those far-reaching theories which have grown out of them during the century now drawing to its close; and this has led him to give an outline of the course of modern research in such things as the theory of equations, function-theory, projective geometry, and non-Euclidian geometry. Moreover, he has not neglected to draw attention to the various tendencies of contemporary schools, and the directions of current investigation.

To do all this in such brief compass has involved severe limitations. Prof. Fink writes for the mathematical student, not for the dilettante, and assumes that his reader is acquainted with the ordinary technical terms of the science. Legendary biographies and items of irrelevant gossip are rigorously excluded; the author has faith enough in the intrinsic interest of his subject to refrain from larding it with scraps of tittle-tattle. The style, too, is concise almost to a fault; the translation, at any rate (and, we should imagine, the original work as well), is not distinguished either by grace or lucidity. But the substantial merits of the book, its well-considered plan its general trustworthiness, and its stimulating character, deserve cordial recognition.

In a work of this kind mistakes in detail are practically unavoidable. No one man possesses such a thorough knowledge of mathematics as to protect him from occasional error when he tries to make a survey of the whole field, or of any considerable part of it. For the correction of such inevitable errors the author must depend

upon the help of those who have paid special attention to particular lines of research; and it is with the intention of doing a service of this kind that the remarks which now follow have been made.

On p. 137 "the form $x \equiv a$ (mod. b), identical with $\frac{x}{b}=y+a$" should be corrected, at the end, by printing $x=by+a$. On p. 142 Reuschle's tables of 1856 are mentioned, but not his "Tafeln complexer Primzahlen" (Berlin, 1875). By an extraordinary oversight, it is said, on p. 207, that "we can construct a regular polygon of n sides only when $n-1=2^{2^p}$ (p an arbitrary integer)," although a correct statement (so far as it goes [1]) is given, pp. 161–2. On page 162, again, it is apparently said that Baltzer was the first to notice that 2^n+1 is not always prime when n is a power of 2; as a matter of fact, Euler proved that $2^{32}+1$ is divisible by 641 (*cf.* Smith's "Report on the Theory of Numbers," Art. 61).

On page 259, after explaining von Staudt's interpretation of "imaginary points" as double elements of involution-relations (which is not strictly correct: the involution itself, *plus* a distinguishing "sense," is the imaginary point), the author says, "This suggestion of von Staudt's, however, did not become generally fruitful, and it was reserved for later works to make it more widely known by the extension of the originally narrow conception." Besides being rather disparaging in tone, this is likely to convey a wrong impression. It is true that Kötter and others, in trying to extend von Staudt's theory to curves of higher orders, have been led to introduce involutions of a more general kind than his; but this does not affect his definition of an imaginary point, which is perfectly general and complete. The imaginary points in which a curve of any order is met by any line must admit (theoretically) of representation by involutions in von Staudt's sense: just as an equation with ordinary complex coefficients has a set of ordinary complex roots. The equation may be, from some points of view, insoluble or irreducible, and we may find it convenient to keep all its roots together; it is this which corresponds to the case of these "higher" involutions.

There are some obscurities which may be due to the author or translators or both. Thus, p. 250, "Möbius started with the assumption that every point in the plane of a triangle ABC may be regarded as the centre of gravity of the triangle:" (this is partially cleared up by the context). On p. 205, line 4, the sentence beginning "The semiparameter" is unintelligible, and is probably a mistranslation. Page 147, "the theory of binary forms has been transferred by Clebsch to that of ternary forms (in particular for equations in line co-ordinates)" is a very inadequate account of Clebsch's "Uebertragungsprincip," and will hardly convey any definite idea to the average reader.

Two obvious slips in translation may perhaps be mentioned. On p. 270, through not noticing an idiomatic inversion, the subject of a sentence has been treated as the predicate, and *vice versâ*: read "this point is offered by the eleventh axiom." On p. 203, for "and also with the normals" read "that is to say, with the normals:" *also* has been confused with *auch*, or rather with our "also." Finally, by the omission of an "s," Plücker has been made to say that "he (Monge) introduced the equation of the straight line into analytical geometry."

At the end of the book there are short biographical notices of a number of mathematicians: the list has been recast by the translators. Whether it is worth the space it occupies (26 pp.) is rather doubtful. Many entries are either trivial, or anticipated in the previous part of the book. Some of the notes are misleading, to say the least. Cauchy is said to have "contributed" to the theory of residues, the fact being that he invented it. All that is said of Eisenstein is that "he was one of the earliest workers in the field of invariants and covariants"; this is true in a sense, but his fame rests principally on his arithmetical memoirs, and his researches on doubly infinite products and elliptic unctions. Sophie Germain "wrote on elastic surfaces." Legendre "discovered the law of quadratic reciprocity," an erroneous statement which may be corrected by p. 138 of the book itself. And what is the use of such entries as "Donatello, 1386—1468. Italian sculptor"? It would be an improvement to cut down this list to the really important names, and to give indications of such trustworthy biographies, or other sources of information, as may be available. G. B. M.

[1] The necessary and sufficient condition that a regular polygon of n sides may admit of Euclidean construction with rule and compass is that the "totient" of n is a power of 2; in other words, $n=2^m pqr \ldots$, where m is zero or any natural number, and $p, q, r \ldots$ are *different* odd primes, *each* of the form 2^k+1. The values of n below 100 are excluding 2) 3, 4, 5, 6, 8, 10, 12, 15, 16, 17, 20, 24, 30, 32, 34, 40, 48, 51, 60, 64, 68, 80, 85, 96.

THE SCIENCE OF COLONISATION.

New Lands: their Resources and Prospective Advantages. By H. R. Mill, D.Sc., LL.D. Pp. xi + 280. (London: Charles Griffin and Co., Ltd., 1900.)

THE present is a very appropriate time for the publication of this book. Public attention is occupied with Imperialism and colonial development, so that a trustworthy statement of the resources and conditions of life in the countries of the temperate zone, where there is still an opening for the energies of English-speaking people, should be of real service. The colonies and countries described from this point of view are Canada, Newfoundland, United States, Mexico, Temperate Brazil, and Chile, Argentina, the Falkland Islands, Australia and Tasmania, New Zealand and South Africa. To intending settlers and capitalists desiring to know the prospects of success in these countries the book will be invaluable; for it brings together in a convenient and concise form all the essential particulars available in official reports and other authoritative works.

This is what the practical man wants, and he will probably not concern himself seriously with the chapter in which the development of new lands is considered in its scientific aspects, yet to our minds this chapter is the most valuable in the book, and every statesman and colonial official anxious that the progress of his country shall be steady and permanent should be familiar with the principles it contains. It is an instructive statement of the factors which ought to be considered in connection with the development of every land, but are often neglected.

Take, for instance, the subject of geographical boundaries. It is the British habit not to give any serious attention to this subject until forced to do so by a dispute with a neighbouring nation. As Dr. Mill remarks:

"Such a muddle as that respecting the boundary of Alaska, and futile suggestions like those which were made for the boundaries of British Guiana, before the final settlement, could never have been made if the statesmen who were responsible had consulted geographers, and had acted on their advice."

Related to this is the subject of topographical surveys. It ought to be a political axiom that a Government should know its country; but we are all aware how frequently this duty is neglected, and the war in South Africa has brought the deficiency into unpleasant prominence. Even the "man in the street" is now in a state of mind to agree that

"If the survey of British South Africa had been begun years ago, or even as late as 1880, and pushed forward with an ample supply of trained surveyors, the war of 1899-1900 within its borders would have been simpler, safer and immensely cheaper."

In addition to topographical surveys, there should be geological surveys, hydrographic surveys, climatological surveys, biological surveys, and other official determinations of the features, fauna and flora of the country, with a view to possessing trustworthy information for future as well as present service. The fundamental value of a knowledge of rainfall in determining the value of colonisable countries is not often recognised, though so much depends upon it. How important an extensive system of rain measurement is in some new countries is shown by the fact that Australians in their calculations often convert inches of rain into numbers of sheep or even pounds of wool per acre. This and other similar cases justify Dr. Mill's remark that

"in almost every case it will be found that the crux of a new land is the water supply. Water, as rain or rivers, is indeed the very life-blood of the habitable world, and the phenomena of its circulation are often complicated, and require much study to elucidate."

It is unnecessary in these columns to give further instances of the dependence of the success of the colonist upon the scientific information available concerning his adopted country. The difficulty is to relieve practical politicians of the thought that knowledge for which there is no immediate use is useless; they have no sympathy with purely scientific work, therefore they are unwilling to encourage it. Let us hope that in the course of time our statesmen will receive an early training in scientific method and foresight, sufficient to enable them to consider colonisation as a study in anthropogeography instead of a haphazard system of settlement.

OUR BOOK SHELF.

The Child: a Study in the Evolution of Man. By A. F. Chamberlain, M.A., Ph.D. Pp. i—xii + 495. With Illustrations. The Contemporary Science Series. (London: Walter Scott, Ltd., 1900.)

This book is intended as a study of the child in the light of the literature of evolution; an attempt to record and, if possible, interpret some of the most interesting and important phenomena of human beginnings in the individual and in the race. Anthropology, as a science embracing many aspects of the human race, is concerned with inquiry as to the evolution of man, and applies fresh knowledge, gained by scientific methods, to the correlation of ascertained facts. The book refers more to the psychological aspect of human development than to the physiological causes of evolution; dealing in a philosophical spirit—not always by strictly scientific processes—with the several subjects dealt with, evidence is afforded by the collection of data and the opinions expressed by many writers rather than based upon the author's own observations and arguments.

In the opening chapter on "the helplessness of infancy" the results that follow from early weakness and the prolonged period of dependency are shown by numerous quotations, while explanation is afforded by reference to Mr. Fiske's view that this has led to the lengthened association of children with their parents and thus developed social habits. The comparative adolescence and longevity of man and animals is shown, and the dictum of Schleiermacher, "Being a child must not hinder becoming a man; becoming a man must not hinder being a child," suggests application to education.

The periods of childhood suggested as distinctive of stages in development are numerous, and definitions from Pythagorus downwards are given. Dr. Chamberlain says, "not only does the child seem to recapitulate physically and mentally the chief points of the race's history, but his own development is fairly teeming with epochs and periods, isolated spots sometimes, the interpretation of which is not yet at hand." The examples given are very interesting, but do not convince us that there is sufficient evidence of any standard by which normal psychological development can be judged. The successive manifestations of mental growth in children form a promising field in child-study; the account given of the linguistic periods in the advance towards speech forms one of the most interesting chapters in this book. Other chapters are explanatory of the relations of the child with the savage and criminal showing certain analogies, but do not afford much guidance in studying child-evolution or explain why the children are such as we find them to be.

The desire to explain the evolution of infancy has sometimes led the author wide of the teaching of scientific views, as when he says, p. 442, "The moment Nature decided that, with man, the struggle for existence was ultimately to be altruistic, rather than selfish, she was forced to make man weak in order to ensure his later strength in the right direction." Such teaching leads the student to neglect the facts of physiology and the effects of physical environment.

The book presents much of interest to the philosophical reader, and maintains the contention that the teaching of evolution and child-study should go hand in hand as mutually instructive.

The value of this volume would be increased by a table of contents; this want is accentuated by the brevity of the index. Eighteen illustrations afford useful explanations of types of manhood and the artistic productions of children.

Sieroterapia e Vaccinazioni preventive contro La Peste Bubonica. Dott Alessandro Lustig. Pp. vi + 150. (Torino: Rosenberg and Sellier, 1899.)

This book gives an account of the preparation of anti-plague serum by the author's method.

According to Prof. Lustig, a considerable degree of immunity against plague is obtained by inoculating animals with a nucleo-proteid contained in the bodies of the bacilli. A culture of plague bacilli grown on solid media is scraped off and dissolved in a 1 per cent. solution of caustic potash. After washing and passing through a Chamberland filter, the substance is used for inoculating horses.

After repeated inoculations the horses are bled, and the serum is used for treatment of plague patients.

Or a solution of the nucleo-proteid may be used as a prophylactic, as advocated by Prof. Lustig and Galeotti (*British Medical Journal*, February 10, 1900). The curative treatment was tried for a period at the Arthur Road Hospital, Bombay, but the results were not very

satisfactory. We have now however a paper before us, by Dr. A. Mayr, read at the Bombay Medical Union, April 21, 1900, dealing with more recent trials, in which there were 38·2 per cent. of recoveries in 403 patients treated, the recoveries of patients under ordinary treatment being 19·5 per cent.

Whether the nucleo-proteid be used as a prophylactic to inoculate persons or to immunise horses to prepare a curative serum, it is evident that the antitoxin given rise to in the person or the horse is an antitoxin against the poisonous nucleo-proteid; the stakes in the race for recovery are all placed on the nucleo-proteid.

But it is not improbable that the metabolic products formed by the plague microbe in the medium it grows on—be it the body or an artificial medium—require to be immunised against, and herein lies the distinction between Haffkine's prophylactic and Lustig's nucleo-proteid used as a prophylactic. Haffkine uses the bodies of the bacilli together with the broth they have grown in, for he considers the broth acted upon by their growth to be useful if not essential. This has been shown to be the case in experiments on animals by Dr. Balfour Stewart (*British Medical Journal*, March 3, 1900).

Lustig's nucleo-proteid prophylactic has some technical advantages in its preparation over Haffkine's, but for the reasons pointed out above it is not likely to be as efficacious. C. B. S.

A Monograph of the Erysiphaceae. By Ernest S. Salmon, F.L.S. "Memoirs" of the Torrey Botanical Club. Vol ix., Pp. 292. (New York: 1900).

THE Torrey Botanical Club has performed a valuable service to mycologists in the publication of this excellent monograph of the Erysiphaceæ, a group of parasitic fungi causing the diseases known as white mildew, powdery mildew, blight, *Mehlthau*, *blanc*, &c. In their conidial or "oidium" stage they are common throughout the summer on various host-plants, such as roses, hops, vines, peas, maples, and many wild plants, giving a mealy appearance to the part infected; while in the later summer or autumn the perfect ascigerous form is produced in the form of dark brown or black spots, consisting of peritheces containing ascospores, and usually provided with characteristic appendages.

The number of known species of this well differentiated group of fungi is not large; the author describes forty-nine, including a very few new ones, in addition to a number of well-marked varieties. These are arranged in six genera, Podosphæra, Sphærotheca, Uncinula, Microsphæra, Erysiphe, and Phyllactinia. Great confusion exists in the nomenclature of the European species, and the author corrects several prevalent errors. He regards the ascus as the result of a true sexual process, and does not support Dangeard's view that the fusion of the nuclei in the young ascus is of sexual signification.

The monograph is illustrated by nine plates, and is supplemented by a very copious bibliography, in which no less than 400 distinct works or papers are referred to, and a host-index of the plants attacked by these fungi. A. W. B.

An Old Man's Holidays. By The Amateur Angler. Pp. xii + 140. (London: Sampson Low, Marston and Co., 1900.)

"AN AMATEUR ANGLER" is an observer of nature as well as an enthusiastic Waltonian, the result being that these holiday sketches contain here and there an observation of interest to naturalists. Referring to the growing scarcity of kingfishers he says, "This is partly owing to the fact that they have the credit of being destructive enemies of young trout; the fact is, they do feed on little fishes, but not so much on trout as on minnows, dace, sticklebacks, miller's thumbs, and even leeches" The book contains several illustrations of rural scenes.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Buchner's Zymase.

THE most recently issued number of the *Proceedings* of the Royal Society (No. 438) contains a paper by Dr. McFadyen, Dr. Morris and Mr. Rowland on the subject of Buchner's zymase, which is held by many observers to be the alcohol-producing enzyme of yeast.

The authors describe a long series of experiments which they have carried out, partly on Buchner's lines, and partly by new methods of their own. They find, as Buchner and other investigators have done, that yeast will, under proper conditions, yield up an extract which can set up alcoholic fermentation in a solution of cane sugar. Many very interesting points have come out during the progress of their work, the explanation of which is not at present very obvious; their conclusion, however, seems to call for a very careful scrutiny of the operations, especially as it has been advanced by other writers also. They state at the end of their paper that their experiments cause them to doubt the existence of an enzyme, and lead them rather "in the direction of a theory which refers the phenomenon to the vital activity of the yeast-cell protoplasm" (p. 265).

In reviewing their experiments it is noticeable that, in their preparation, the yeast was mixed with a certain proportion of kieselguhr, and subjected in this condition to the enormous pressure of 200-300 atmospheres (p. 252). The liquid thus expressed was capable of filtration under pressure through a Chamberland or Berkefeld filter (p. 259) without losing its properties, though the process decreased its power. It was miscible with, or soluble in, a small quantity of water or solution of cane-sugar without being altogether destroyed, though too much of the solvent inhibited its action (p. 262). The experiments were conducted throughout in the presence of antiseptics, such as 1 per cent. of sodium arsenite, thymol, or toluol (p. 254).

It will be difficult for physiologists to accept a conception of a protoplasm which is not destroyed by such a pressure as was used, and which afterwards becomes to some extent soluble in water, or, at any rate, miscible with it, which can be filtered through a porcelain filter without destruction, and which can carry on an anabolic and subsequently a katabolic process (p. 265) in the presence of such antiseptics as were used.

The authors say in an earlier part of the paper (p. 253) that such a kieselguhr "sponge" as they obtained during the extraction of the yeast was capable of retaining almost entirely the globulins of eggs, and, to a large extent, albumin and serum proteids. It seems strange after this to find them holding the view that protoplasm itself was not retained by such a "sponge."

It is a little difficult to reconcile their concluding theory of a fluid protoplasm with their statement (p. 253) that the juice they obtained and used was in every case far removed in nature from the condition in which it existed when alive in the yeast cell, even if one were to admit that the *juice* was ever living at all. Is it possible, in their opinion, for the anabolic and katabolic activities of protoplasm to be manifested in such a juice as they describe in those words? Yet their final hypothesis is that the yeast juice exhibits the "vital activity of the yeast-cell protoplasm."

I venture to disagree with their conclusion. In my own experiments, which were published in the *Annals of Botany*, vol. xii (1898), p. 491, I found that an active preparation could be obtained by grinding the yeast with kieselguhr in such proportion that a perfectly dry impalpable powder resulted, and then extracting the latter with a solution of cane-sugar. It is hardly credible that protoplasm without the protection of cell-walls, can resist desiccation. The action of the extract in my experiments, as in theirs, was considerable in the presence of antiseptics which, in the proportions used, were inevitably and rapidly fatal to the life of protoplasm.

Cambridge, November 19. J. REYNOLDS GREEN.

Euclid i. 32 Corr.

MR. TUCKER is right (p. 58) in his conjecture that Clavius was not the first to publish these corollaries.

References:—P. Ramus (ob. 1572), "Scholar^m. Math^m. Libri unus et triginta. *A Lazaro Schonero recogniti et emendati*,"

p. 180. Francofurti, 1599; H. Billingsley, the first English translation of the "Elements of Euclid," Fol. 42. (London, 1570); N. Tartalea Brisciano, "Euclide," Fol. 32. (Venetia, 1565); J. Peletarius, "In Euclidis Elementa Geometrica Demonstrationum Libri sex." Prop. 32. *Appendix a Campano*, pp. 33, 34. (Lugduni, 1557).

It is much to be regretted that in this country so little importance is attached to the history of mathematics; otherwise, such mistakes as those mentioned by Mr. Tucker would not be repeated from one text book to another.

Galway, November 17. GEORGE J. ALLMAN.

Instruments of Precision at the Paris Exhibition.

IN your issue of November 15 (p. 61) is an account of "Instruments of Precision at the Paris Exhibition," in which it is stated that a catalogue of 250 pages has been prepared by the German Association of Mechanicians and Opticians. May I ask you to state in some future issue how that catalogue can be obtained, as I am anxious to get a copy of it?

E. T. WARNER.

H.M.S. *Britannia*, Dartmouth, November 21.

I AM much interested in the article in the number of NATURE for November 15, on optical and other instruments at the Paris Exhibition. Although I visited the exhibition, I did not see the exhibit, as I went too soon after the opening. I should much like to obtain the catalogue mentioned. Will you kindly tell me where I should be able to obtain one by writing for it?

H. DAVIDGE.

Seafield Park College, Crofton, Hants, November 17.

[For information as to the German Catalogue of Scientific Instruments, application should be made to Dr. Robert Drosten, Bureau de l'Exposition allemande des Instruments de Precision, Classe 15, Section 3, Exposition Universelle, Paris. If Dr. Drosten is not in Paris, letters will probably be forwarded. The secretary of the German Committee of Management is Prof. St. Lindeck, Reichsanstalt, Charlottenburg, Berlin, who no doubt would send a catalogue.—ED. NATURE.]

ON SOLAR CHANGES OF TEMPERATURE AND VARIATIONS IN RAINFALL IN THE REGION SURROUNDING THE INDIAN OCEAN.[1]

I.

THE fact that the abnormal behaviour of the widened lines in the spectra of sunspots since 1894 had been accompanied by irregularities in the rainfall of India suggested the study and correlation of various series of facts which might be expected to throw light upon the subject.

The conclusions already arrived at from bringing together the results of several investigations undertaken with this view may be stated as follows:—

(1) It has been found from a discussion of the chemical origin of lines most widened in sunspots at maxima and minima periods that there is a considerable rise above the mean temperature of the sun around the years of sunspot maximum and a considerable fall around the years of sunspot minimum.

(2) It has been found from the actual facts of rainfall in India (during the S.W. monsoon) and Mauritius, between the years 1877 and 1886,[2] as given by Blanford and Meldrum, that the effects of these solar changes are felt in India at sunspot maximum, and in Mauritius at sunspot minimum. Of these the greater is that produced in the Mauritius at sunspot minimum. The pulse at Mauritius at sunspot minimum is also felt in India, and gives rise generally to a secondary maximum in India.

India therefore has two pulses of rainfall, one near the maximum and the other near the minimum of the sunspot period.

(3) It has been found that the dates of the beginning of these two pulses on the Indian and Mauritius rainfall are related to the sudden remarkable changes in the behaviour of the widened lines.

(4) It has been found from a study of the Famine Commission reports that all the famines therein recorded which have devastated India during the last half century (we have not yet carried the investigation further back) have occurred in the intervals between these two pulses.

(5) It has been found from the investigation of the changes in (1) the widened lines, (2) the rainfall of India and (3) of the Mauritius during and after the last maximum in 1893 that important variations from those exhibited during and after the last maximum of 1883 occurred in all three.

It may be stated at the same time that the minimum of 1888–1889 resembled the preceding minimum of 1878–1879.

(6) It has been found from an investigation of the Nile curves between the years 1849 and 1878 that all the lowest Niles recorded have occurred between the same intervals.

(7) The relation of the intervals in question to the droughts of Australia and of Cape Colony, and to the variations in the rainfall of extra tropical regions generally has not yet been investigated. We have found, however, a general agreement between the intervals and the rainfall of Scotland (Buchan), and have traced both pulses in the rainfalls of Córdoba (Davis) and the Cape of Good Hope.

(8) We have had the opportunity of showing these results to the Meteorological Reporter to the Government of India and Director-General of Indian Observatories, John Eliot, Esq., C.I.E., F.R.S., who is now in England, and he allows us to state his opinion that they accord closely with all the known facts of the large abnormal features of the temperature, pressure and rainfall in India during the last twenty-five years, and hence that the inductions already arrived at will be of great service in forecasting future droughts in India.

Solar Physics Observatory, October 26.

ADDENDUM.

Since Meldrum and one of us called attention, in 1872 to a possible connection between sunspots and rainfall, there has been a large literature upon the subject which it is not necessary for us to analyse; it may be simply stated that, in spite of the cogent evidence advanced since, chiefly by Meldrum, and in later years by Mr. Hutchins,[1] it is not yet generally accepted that a case for the connection has been made out.

What has been looked for has been a change at maximum sunspots only; the idea being that there might be an effective change of solar temperature, either in excess or defect, at such times; and that there would be a gradual and continuous variation from maximum to maximum.

At the same time, it is possible that the pressure connection, first advanced by Chambers, is now accepted by meteorologists as a result of the recent work of Eliot.

The coincidence, during the last few years, of an abnormal state of the sun with abnormal rain in India, accompanied by the worst famine experienced during the century, suggested to us the desirability of reconsidering the question, especially as we have now some new factors at our disposal. These have been revealed by the study, now extending over twenty years, of the widened lines in sunspots, which suggested the view that two effects ought to be expected in a sunspot cycle instead of one.

[1] By Sir Norman Lockyer, K.C.B., F.R.S., and W. J. S. Lockyer, M.A. (Camb.), Ph.D. (Gött.). Paper read before the Royal Society on November 22.

[2] This period was selected because the Kensington observations of widened lines only began in 1879, and the collected rainfall of India has only been published to 1886.

[1] "Cycles of Drought and Good Seasons in South Africa, 1889."

The Widened Lines.

It will be gathered from previous communications to the Royal Society[1] that, on throwing the image of a sunspot on the slit of a spectroscope, it is found that the spectrum of a spot so examined indicates that the blackness of the spot is due, not only to general, but to selective absorption,[2] and that the lines widened by the selective absorption vary from time to time.

Since the year 1879, the *selective* absorption in spots has been observed for every spot that was large enough to be spectroscopically examined; the method adopted being as follows:—

The regions of the spectrum investigated lie between F—*b* and *b*—D, and an observation consists in observing the six most widened lines in each of these regions. These lines are then identified on the best solar spectrum maps available and their wave-lengths determined.

An examination of many years' records of these widened lines has shown that at some periods they are easily traceable to *known* elements, while at others their origins have not been discovered, so the latter have been classed as "unknown" lines. If we compare these two periods with the sunspot curve as constructed from the measurements of the mean spotted area for each year, it is found that when the spotted area is greatest the widened lines belong to the "unknown" class, while when the spotted area is least they belong to the "known" class.

The majority of the lines traced to some terrestrial origin belong to iron, but the lines of other elements, such as titanium, nickel, vanadium, scandium, manganese, chromium, cobalt, &c., are also represented in a less degree.

It is quite likely that some of the "unknown" lines are higher temperature (enhanced) lines of known chemical elements.

In our laboratories we have means of differentiating between three stages of temperature, namely, the temperature of the flame, the electric arc, and the electric spark of the highest tension. At the lowest temperature, that of the flame, we get a certain set of lines; a new set is seen as the temperature of the electric arc is reached. At the temperature of the high tension spark we again have many new lines, called enhanced lines, added, while many of the arc lines wane in intensity.

It is found that at sunspot minimum, when the "known" lines are most numerous, the lines are almost invariably those seen most prominent in the arc. Passing from the sunspot minimum towards the maximum the "unknown" lines gradually obtain the predominance. As said before, they may be possibly "enhanced lines"—that is, lines indicating the action of a much higher temperature on *known* substances.

Unfortunately the records of enhanced lines at South Kensington, having been obtained from photographs, are chiefly confined to a region of the spectrum not covered by the visual observations of widened lines in sunspot spectra.

We can only point to the evidence acquired in the case of one metal—iron, for which photographs of the enhanced lines in the green and yellow parts of the spectrum have been obtained.

This evidence quite justifies the above suggestion, for the enhanced lines of iron can be seen revealing themselves as the number of unknown lines increases.

We are, therefore, quite justified in assuming a very great increase of temperature at the sunspot maximum when the "unknown" lines appear alone.

The curves of the "known" and "unknown" lines have been obtained by determining for each quarter of a year the percentage number of known and unknown lines and plotting these percentages as ordinates and the time elements as abscissæ. Instead of using the mean curves for all the known elements involved, that for iron is employed, as it is a good representative of "known" elements, and has been best studied. When such curves have been drawn they cross each other at points where the percentage of unknown lines is increasing, and that of the iron or known lines are diminishing, or *vice versâ*.

We seem, therefore, to be brought into the presence of three well-marked stages of solar temperature.

When the curves of known and unknown lines cross each other, that is, when the number of known and unknown lines is about equal, we must assume a mean condition of solar temperature. When the unknown lines reach their maximum we have indicated to us a + pulse or condition of temperature. When the known lines reach their maximum we have a − pulse or condition of temperature.

The earliest discussion showed that, generally speaking, the unknown-lines curve varied directly, and the iron-lines curve varied inversely with the spot-area curve. The curves now obtained for the whole period of twenty years not only entirely endorse this conclusion, but enable more minute comparisons to be drawn.

The "widened line" curves are quite different from those furnished by the sun-spots. Ascents and descents are both equally sharp, changes are sudden, and the curves are relatively flat at top and bottom. The crossings are sharply marked.

During the period since 1879 three such crossings have occurred, indicating the presence of mean solar temperature conditions, in the years 1881, 1886-7,[1] and 1892. It was expected that another crossing with the known lines on the rise would have occurred in 1897, indicating thereby the arrival of another mean condition of solar temperature, but as yet no such crossing has taken place.

The following tabular statement shows the years of those crossings, together with the probable dates, in brackets, of the two previous crossings, as determined by the time of occurrence of the preceding sun-spot maximum.

Rise of	Years		
Unknown lines ...	(1869)	1881	1892
Known lines ...	(1876)	1886–7	?

Comparison of Solar and Terrestrial Weather.

It has long been known that a cycle of solar weather begins in about lat. 32° N. and S., and in a period of 11 years ends in about lat. 5° N. and S.

Just before one cycle ends another commences. The greatest amount of spotted surface occurs when the solar weather-changes produced in the cycle reach about lat. 16° N. and S.

It becomes, therefore, of the first importance to correlate the times of mean solar temperature, and of the + and − heat pulses, with the solar weather cycle, in order to arrive at the temperature-history of the sun during the period which now concerns us. This may be done as follows:—

Solar cycles				→				→		→
Lat. of spots	19°	16°	12°	9°	18°	17°	10°	7°	19°	18°
Heat condition	mean	+	mean	−	mean	+	mean	−	mean	+
Years	1869	1870–5	1876	1877–80	1881	1882–6	1886–7	1888–91	1891–2	1892–

[1] *Proc. Roy. Soc.*, vol. xl. p. 347, 1886; vol. xlii. p. 37, 1887; vol. xlvi. p. 385, 1889; vol. lvii. p. 199, 1894.

[2] *P.R.S.*, Lockyer, 1866, October 11.

[1] According to the observations the mean was reached in December 1886, or January 1887.

Connection of the Spots with Prominences.

In 1869, when a sun-spot maximum was approaching, the prominences were classified by one of us into *eruptive* and *nebulous;* the former showing many metallic lines, the latter the hydrogen and helium lines chiefly. This conclusion, which was published in 1870, was subsequently confirmed and adopted by Secchi, Zöllner, Spörer, Young and Respighi.

In the same year prominences on the sun's disc were also observed by one of us by means of the C and F lines.[1]

The eruptive prominences, unlike the nebulous ones, were not observed in all heliographic latitudes; but, according to the extended observations of Tacchini and Ricco, had their maxima in the same latitude as the spots. This is especially well shown by the diagrams illustrating the distribution of spots, faculæ, eruptions and protuberances which are given by Tacchini for 1881–1887 in the *Memoria della Soc. degli Spettroscopisti Italiani*, 1882–1888. These curves show in the most unmistakable manner that the spots, faculæ and eruptive or metallic prominences have their maximum frequency in the same solar latitudes while the nebulous or quiet prominences are more uniformly distributed, and even have maxima in zones where spots are rarely observed. This is corroborated by what Prof. Respighi many years ago stated:

"In correspondence with the maximum of spots, not only does the number of the large protuberances increase, but more than this—their distribution over the solar surface is radically modified."

In his observations, Prof. Young found that the H and K lines of calcium were reversed in the chromosphere as constantly as *h* or C, and the same lines "were also found to be regularly reversed upon the body of the sun itself, in the penumbra and immediate neighbourhood of every important spot."[2] This result was confirmed by the early (1881) attempts of one of us to photograph the spectra of the chromosphere and spots, and also by eclipse photographs. In the photographic spectrum, the H and K lines are by far the brightest of the chromospheric lines, and this fact has been utilised by Hale and Deslandres acting on a suggestion due to Janssen, for the purpose of photographing at one exposure the chromosphere and prominences, as well as the disc of the sun itself, in the light of the K line.

These photographs thus give us in K light the phenomena which one of us first observed by the lines C and F of hydrogen, and thereby present a record of the prominences across the whole disc of the sun as well as at the limb.

In such photographs near sunspot maximum, the concentration of the prominences in zones parallel to the equator is perfectly obvious at a glance. Eruptive or metallic prominences are thus seen to cover a much larger area than the spots, so that we have the maximum of solar activity indicated, not only by the increased absorption phenomena indicated by the greater number of the spots, but by the much greater radiation phenomena of the metallic prominences; and there seems little doubt that in the future the measure of the change in the amount of solar energy will be determined by the amount and locus of the prominence area.

Spots are, therefore, indications of excess of heat, and not of its defect, as was suggested when the term "screen" was used for them. We know now that the spots at maximum are really full of highly heated vapours produced by the prominences, which are most numerous when the solar atmosphere is most disturbed.

The Indian meteorologists have abundantly proved that the increased radiation from the sun on the upper air currents at maximum is accompanied by a lower temperature in the lower strata, and that with this disturbance of the normal temperature we must expect pressure changes. Chambers was the first to show that large spotted area was accompanied by low pressures over the land surface of India ("Abnormal Variations," p. 1).

Passing, then, from the consideration of individual spots to the zones of prominences, with which they are in all probability associated, it is of the highest interest to note the solar latitudes occupied when the crossings previously referred to took place, as we then learn the belts of prominences which are really effective in producing the increased radiation. The area of these is much larger, and therefore a considerable difference of radiation must be expected.

The greater disturbance of certain zones of solar latitude seems to be more influential in causing the + pulse than the amount of spotted area determined from spots in various latitudes.

It is all the more necessary to point this out because the insignificance of the area occupied by the spots has been used as an argument against any easily recognised connection between solar and terrestrial meteorological changes.[1]

Assuming two belts of prominences N. and S., 10° wide, with their centres over Lat. 16°, a sixth of the sun's visible hemisphere would be in a state of disturbance.

(*To be continued.*)

1 *P.R.S.*, 17, p. 415.

2 "Catalogue of Bright Lines in the Spectrum of the Chromosphere" (1872).

THE KITE WORK OF THE UNITED STATES WEATHER BUREAU.

EARLY in the year 1898, the Congress of the United States granted a sum of money, to be expended under the direction of the Chief of the Weather Bureau, for the establishment and maintenance of a series of stations at which observations of the upper free air were to be made by means of automatically recording mechanisms attached to kites. This work was to be undertaken primarily in the hope that daily simultaneous observations might be obtained at definite altitudes, thus permitting the construction of daily synchronous charts of pressure, temperature, and wind direction and velocity, which, when studied in connection with corresponding surface charts, would admit of some advance being made in the present system of weather forecasting, both in accuracy and in the duration of the periods forecasted for.

FIG. 1.—Kite with meteorograph in position.

Seventeen stations were established in the spring of

1 "So far as can be judged from the magnitude of the sun-spots, the cyclical variation of the magnitude of the sun's face free from spots is very small compared with the surface itself; and consequently, according to mathematic principle, the effect on the elements of meteorological observation for the whole earth ought also to be small" (Eliot, "Report on the Meteorology of India in 1877," p. 2).

the year 1898, mostly in the great river valleys and the upper portion of the region of the Great Lakes. The form of kite used was the Hargrave cellular (Fig. 1), with such modifications and improvements as trial and experiment dictated. The surface dimensions of the

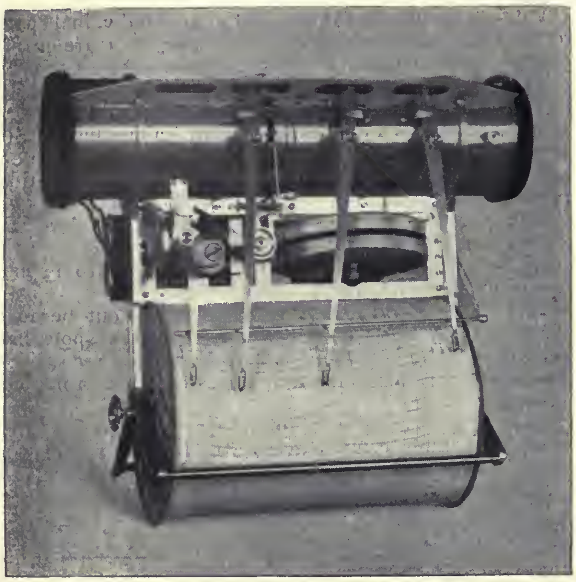


FIG. 2.—Kite meteorograph.

kites varied from 45 to 72 square feet. The kite line was carried on a large iron drum or reel, capable of resisting a crushing pressure of at least 1000 tons, and consisted of steel piano-wire ·028 inch in diameter, and weighing 2·15 pounds to the thousand feet, or 11·35 pounds to the mile. The tensile strength of this wire at the breaking-point was about 200 pounds.

With a kite flying at an elevation of from 5000 to 7000 feet, from 8000 to 10,000 feet of wire would be out, making a weight of from 90 to 115 pounds which must be sustained by the kite.

The meteorograph (Fig. 2), or automatic recording apparatus, was devised by Prof. C. F. Marvin, of the Weather Bureau. It weighs but a fraction over two pounds, is inclosed in an aluminium case, and, while quite complicated in construction, is remarkable for its compactness and lightness. The cylinders carrying the record sheets are actuated by clockwork, and four different meteorological conditions are recorded, viz., pressure, temperature, relative humidity and wind velocity (Fig. 3). The wind direction, of course, becomes apparent by observing the azimuth of the kite.

It soon became evident that there was no possibility of obtaining a daily synchronous chart. The principal difficulties were the very frequent absence of sufficient wind to sustain the kites, and inability to obtain ascensions in stormy weather. Taken as a whole, ascensions were possible during only 46 per cent. of the time from May to October, inclusive, the percentage varying from 75 at Dodge, Kansas, to 12 at Knoxville, Tennessee. The hours of the day at which ascensions could be made also varied greatly.

But however disappointing the results obtained may have been from the viewpoint of the weather forecaster, they were not so when considered from another. Much valuable data was obtained from the 1217 ascensions and 3835 observations, particularly regarding vertical temperature gradients, and it is believed that there has been a very material contribution made to our previous knowledge of this subject. Briefly summarised, the results of the observations were as follows:—

The mean rate of diminution of temperature with increase of altitude was found to be 5° F. for each 1000 feet, or only 0·4° less than the true adiabatic rate. The gradient was greatest up to 1000 feet, where it was 7·4° F.; from thence up to 5000 feet there was a steady decrease to 3·8° a thousand feet, the rate of decrease varying inversely with the altitude. Above 5000 feet there was a tendency toward a slight increase.

The mean gradients on the Atlantic coast were much smaller than those in the interior, the difference being mainly due to the lower morning values of the former, those of the afternoon differing but slightly. Inversions of temperature were quite frequent, and were most pronounced when the upper air currents were from south-east to south-west. Clouds, as a rule, caused a decrease in the rate of temperature fall, sometimes so decided as to result in an actual temperature inversion. A series of observations was made at Pierre, South Dakota, during the winter of 1898–99, and a cursory examination of the records there made showed such persistent temperature inversions during periods of cold weather as to furnish convincing evidence that during a cold wave the stratum of cold air is not much over one mile in height, and frequently but little over half a mile.

The relative humidity at and above the earth's surface differed but little, and, generally speaking, the upper air percentages were the lower. The mean results were 60

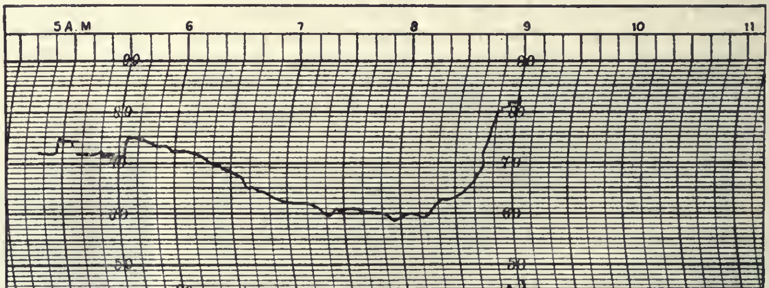


FIG. 3.—Record obtained at Arlington, Virginia, on June 14, 1898.

and 58 per cent. respectively, a difference of 2 per cent. There were, however, some marked differences at individual stations. At Washington, D.C., it was 14 per cent.; at Omaha, Nebraska, 29 per cent.; and at Spring-

field, Illinois, 21 per cent. At Fort Smith, Arkansas, the difference was 12 per cent., but with reversed conditions, the upper air humidity being the higher.

The vapour pressures were compared with others obtained at various times at equal altitudes by means of balloons and mountain observations, and found to be somewhat lower. The average value was 59 per cent., as compared with 68 for the balloon and 66 for the mountain observations. In these data the vapour pressures were represented in percentages obtained by the formula $\frac{p}{p^o}$, p representing the vapour pressure at any given altitude, and p^o that observed simultaneously at the earth's surface.

Differences in wind direction above and at the surface were for the most part confined to a deflection toward the right at the kite. This deflection frequently increased with the altitude, but rarely exceeded 90 degrees. In some few instances, chiefly during unsettled weather, the deflection was toward the left, but not to any great extent.

At the present time efforts are being made to obtain a more improved and satisfactory vehicle for the meteorograph. If such an one can be devised, it is yet possible that the desire of the forecaster will finally be gratified with great resultant benefit both to the cause of science and to the world at large. H. C. FRANKENFIELD.

THE PRESENT CONDITION OF THE INDIGO INDUSTRY.

SINCE a previous article upon the above subject (November 1) was written, a report of the opening of the Hofmann House in Berlin has appeared in the *Times*. At the opening ceremony Prof. von Baeyer and Dr. Brunck delivered lectures upon the synthetical production of indigo. Von Baeyer's lecture dealt chiefly with the theoretical side of the question, while that of Dr. Brunck, who is one of the managing directors of the Badische Anilin und Soda Fabrik, dealt more upon the manufacturing side. As the work of von Baeyer is so well known and was referred to in the previous article, attention will only be drawn to the extremely interesting speech of Dr. Brunck.

In the first place, Dr. Brunck drew attention to the advantages of synthetic over natural or vegetable indigo, owing to its uniformity of composition, fine state of division, ready reducibility, &c. He claimed that a much less skilled operator may be employed in manipulating the dye bath than when natural indigo is used. He then went on to describe the prejudice which the synthetical indigo ("indigo pure") had to contend with when it was first placed on the market in 1897; it being stated by some that it was merely specially refined natural indigo, and by others that it was a substitute for indigo. It is extraordinary how difficult it is to make the public believe that it is possible to prepare in the laboratory a product which is identical in *every* respect to one which is of vegetable origin. In the case of indigo, however, there is perhaps some excuse, because the manufacturers of coal-tar products have often brought out colours which dye practically the same shades as indigo, but though not readily distinguished from it even by experts, have lacked one of the chief characteristics of indigo—fastness. But notwithstanding prejudice and keen competition, the development of the manufactory has been enormous. Dr. Brunck states that about 900,000*l.* has been invested in the indigo department of the Badische Company, and that the quantity of indigo now annually manufactured by this company alone would require the cultivation of nearly 250,000 acres of land in India.

The method of manufacture employed by the Badische Company is that of Heumann, in which phenylglycine-ortho-carboxylic acid (anilido-acetic acid) is fused with caustic soda (*c.f.* NATURE, this volume, p. 9). When this process was first discovered, the cost of the out-going products was so great that indigo so prepared could not compete with the natural product. *The Badische Company employ more than 100 highly-trained research chemists;* to some of these the work of endeavouring to elucidate the problem, how to manufacture phenylglycine-ortho-carboxylic acid cheaply, was entrusted. Taking naphthalene, which is obtained in enormous quantities from coal tar, as starting product, the following process was worked out. The naphthalene is oxidised by highly concentrated sulphuric acid in presence of mercury or mercury salts, with production of phthalic acid. The phthalic acid is then, by a series of reactions, converted into anthranilic acid which, when combined with monochloracetic acid, produces phenylglycine-ortho-carboxylic acid. During the oxidation of naphthalene with sulphuric acid large quantities of sulphur dioxide are produced, the loss of which would be a very serious expense. In preparing indigo upon the scale in which it is now manufactured, from 25,000 to 30,000 tons of sulphur dioxide are produced annually. But this is not lost; it is mixed with air and passed over heated oxide of iron, and is thus by catalytic action converted into sulphuric anhydride, and this by the action of water into sulphuric acid. Chlorine is required in order to prepare chloracetic acid, and caustic soda to fuse the phenylglycine-ortho-carboxylic acid. These two products are obtained by the electrolysis of sodium chloride. As, however, the chlorine as it is first produced is not sufficiently pure, it is purified by condensing it to the liquid condition. Attention has been drawn to the details of the manufacturing process, in order to show what a determined and powerful competition the Indian indigo producer has to face.

Synthetical indigo is being used in this country, but there is a considerable difference of opinion as to whether it is as easy to dye with the artificial as with the natural product. Some dyers state that there is a difficulty in obtaining the requisite bloom and that, therefore, materials dyed with it have a flat or dead appearance; other operators seem to find no such difficulty. Practically the only drawback to materials dyed with indigo is that the dye is inclined to rub. Some dyers say that goods dyed with synthetical indigo rub more than when dyed with the vegetable indigo. This, again, is denied by others. There is also said to be a difficulty in reducing synthetical indigo. In print-work synthetical indigo certainly appears to possess an advantage, owing to its fine state of division and to the fact of its containing no foreign matter which might scratch and injure the rollers. Before natural indigo can be employed, it is necessary to have it in an exceedingly fine state of division, and in order to ensure this it is usually ground in a mill with water for several days. The artificial product, on the other hand, is sent into the market as a very fine powder or in the form of a paste. One drawback to natural indigo is the varying amounts of indigotin which different samples contain. Artificial indigo contains not only a very high percentage of indigotin, but practically no foreign matter.

Dr. Brunck is sanguine that the synthetical product will shortly overcome all competition and drive the natural product from the market; and in his address, with a *disinterestedness* which cannot but be admired, advises the Government of India to ascertain in what manner the land which has been employed for growing indigo may be best cultivated. If the advice of Dr. Brunck is taken, there will be no doubt as to the success of the artificial indigo. As showing the vast importance of the question to India, the following statistics are given. In Northern Behar there are from 250,000 to 300,000 acres of land devoted to the cultivation of indigo,

and nearly one and a half million people are employed in the industry, while three years ago the capital invested in this province was estimated at over 4,000,000*l*. The land under cultivation in Bengal was, in 1899, estimated at 452,700 acres. There seems at last to be some movement among the dry bones; the Indigo Planters' Association have employed Mr. Rawson, who is an expert upon the chemistry of dyeing, to endeavour to improve the process of manufacturing indigo, and appeals are made to the Government for help. The Government is doing its part, and has ordered that all blue cloth supplied to the Army and Navy Clothing Departments shall be dyed with *natural* indigo. At the present time the price of natural and synthetic indigo is almost the same. What will the Government do if the price of synthetic indigo becomes much less than that of natural indigo? Sir William Hudson, in August of this year, applied to the Government for a loan for a scheme of sugar cultivation, suggesting that indigo and sugar-cane should be grown in rotation. The Government, although not able to accede to his request, has sanctioned a committee to inquire into the possibilities of establishing the sugar industry in Behar.

When attention is drawn to the perilous position of the Indian indigo industry, letters are written to the papers by those connected with the production of indigo, making light of the danger, and referring to the "*real* indigo dye and German imitation." But, as Mr. Rawson, who at least is not likely to overrate the artificial indigo, said in his admirable lecture, delivered before the Society of Arts at the end of March, "all chemists who have studied the question agree that synthetic indigo is *identically* the same compound as the indigotin of natural indigo"; and again, "Providing the synthetic dye can be produced in sufficient quantity, the whole question of artificial *versus* natural indigo will resolve itself into one of cost. The Badische Company have spent nearly a million pounds in improving the manufacture of artificial indigo; at Höchst, the "Farben Fabrik" is also manufacturing artificial indigo, though at present they are only supplying the German market. In a letter to the *Times* on April 24, Prof. Armstrong asks, "Have we spent 5000*l*. in the endeavour to set our Indian indigo house in order?" For every British chemist employed it is safe to say the Germans are employing fifty; for every pound spent they are spending thousands. Is it not time to appoint a committee or commission of experts to see whether it may not be possible to increase the yield and quality of the indigo produced, and at the same time to produce it more economically?

F. MOLLWO PERKIN.

NOTES.

PROF. POINCARÉ has been elected a foreign member of the Munich Academy of Sciences.

PROF. KLEIN has been elected a correspondant of the Paris Academy of Sciences, in the section of mineralogy. Prof. Haller has been elected a member of the Academy in succession to the late M. Grimaux.

THE Rammelsberg Memorial Lecture will be delivered at the Chemical Society by Prof. H. A. Miers, F.R.S., on Thursday, December 13.

WE notice in *Science* the announcement that Prof. Schiaparelli retired on November 1 from the directorship of the observatory at Milan, where he has been at work for the past forty years. His successor is Prof. Celoria, heretofore assistant astronomer at the observatory.

AT the annual meeting of the Royal Geological Society of Cornwall, Dr. Le Neve Foster was presented with the William Bolitho gold medal in recognition of the distinction which he has attained as a mineralogist and also of the great services rendered by him to the society as curator during the period when he held the appointment of inspector of mines for Cornwall and Devon.

IT is reported that M. Daniel Osiris, a Greek millionaire residing in Paris, has instituted a prize on the lines laid down by Mr. Nobel, though his offer is for Frenchmen only, except in a Paris Exposition year, when it becomes universal. He has set aside a sum to be awarded every three years in perpetuity to the discoverer, inventor or producer of the most noteworthy idea or object for the benefit of humanity. The prize is to be never less than 100,000 francs, and may be double that sum.

A RUMOUR, which we profoundly regret, has reached us to the effect that, owing to increasing financial difficulties, the Government of Jamaica, W.I., is obliged to retrench in the work of the museum, and that the curator, Dr. J. E. Duerden, A.R.C.S. (London), will be shortly returning to England. During his appointment in the Colony, Dr. Duerden has carried out investigations on the local aboriginal Indian remains and in marine zoology. Among the important results obtained may be mentioned the discovery of the free-swimming female medusoids of Millepora; the discovery that the addition of new mesenteries and septa in the coral Porites takes place in a bilateral manner at the dorsal or ventral aspect of the polyp, recalling the method probably followed in the ancient Rugose corals; the establishment of the fact that the order of septal formation in most Madreporaria follows closely the law ascertained long ago by Prof. Lacaze-Duthiers for the cycles of tentacles in Actiniæ. Can nothing be done to save the Colony from the opprobrium which must follow the forsaking of pure science?

THE value of anti-plague serum is a very vexed question. Yersin in 1896, in China, claimed a mortality of only 7·6 per cent. in twenty-six cases treated with his serum, and the same observer in 1897, in India, using Roux's serum, stated that the mortality was only 49 per cent., as compared with 80 per cent. among the cases not treated with serum. The Indian medical officers and the German Commission, however, reported unfavourably upon his results, and the serum treatment of plague has not been adopted in India. Clemow, in India in 1899, employed both Yersin's and Lustig's sera, but was unable to observe any good results from the use of either. On the other hand, in the outbreak of plague in Oporto last year, Calmette and Salimbeni claim to have obtained excellent results with the use of serum prepared at the Pasteur Institute by the most recent method—viz. by treating horses with increasing doses, first of dead and afterwards of living cultures, of plague bacilli, administered by intravenous injection during a period of five or six months. The mortality of the cases treated with serum was 15·3 per cent., as against 63·7 per cent. for the untreated cases. Calmette holds that for successful treatment the anti-plague serum must be administered in large doses, intravenously to commence with, and afterwards by repeated subcutaneous injection, early treatment being essential. The experimental results are distinctly in favour of the value of anti-plague serum both as a preventive and as a curative agent.

MR. R. HEDGER-WALLACE, formerly of the Department of Agriculture, Victoria, is giving a course of lectures on the "First Principles of Colonisation and Plantation," at the Gardens of the Royal Botanic Society of London. The remaining lectures will be delivered on November 30 and December 7 at three o'clock.

IN consequence of the annual dinner of the Institution of Electrical Engineers being fixed for Monday, December 3, the second lecture of Prof. Fleming's Cantor course at the Society of Arts, on "Electric Oscillations and Electric Waves," announced

for that date will be postponed until the following day, Tuesday, December 4, to suit the convenience of members and others who might be prevented by the dinner from attending it.

THE Council of the Institution of Engineers and Shipbuilders in Scotland is arranging an International Engineering Congress, under the presidency of Lord Kelvin, in connection with the Glasgow International Exhibition of 1901. The leading engineering and kindred societies have already accorded their hearty support to the congress. An influential London Committee has been formed, and the congress gives every promise of being a success.

SIR WILLIAM MACCORMAC, president of the Royal College of Surgeons of England, has received the Royal licence and authority that he may accept and wear the Cross of Commander of the Legion of Honour, conferred upon him by the President of the French Republic, in recognition of services which he rendered to the French wounded during the war of 1870–71, as well as to the International Congress of Medicine held during the recent Paris Exhibition.

AT the end of this year Dr. H. R. Mill will retire from the post of librarian to the Royal Geographical Society, and will be succeeded by Mr. E. Heawood. The scientific appointment which he has accepted will enable him to devote more attention to the investigation of meteorology and oceanography in their relation to the configuration of the ground than has been possible during his nine years' librarianship.

AT the Imperial Institute on Monday an illustrated public lecture was delivered by Mr. Clement L. Wragge, Government Meteorologist of Queensland, on "The Work of the Queensland Weather Bureau, in its Relation to the Natural Resources and Commerce of Australasia." The work of the Queensland Weather Bureau is divided into two main parts, (1) the investigation of local climates, climatology, and (2) forecasting the weather. In speaking of the daily forecasting service, Mr. Wragge said that by an Inter-colonial system of exchange of data his Bureau is daily placed in possession of barometric and other meteorological readings from every part of Australasia, and the forecasts prepared therefrom are published in the principal daily Australasian papers. He advocated the American system of hoisting flags of different designs and colours at the telegraph offices of every town. The comparison of simultaneous observations of the upper regions of the air, made at mountain observatories, with those made at the nearest point on the sea level, are of great value, as meteorologists are thus enabled to obtain practically vertical sections of the atmosphere.

WE have received the twenty-second report of the Deutsche Seewarte, Hamburg, referring to the work of that important institution for the year 1899. The meteorological services of Germany are divided into two parts. The Central Office at Berlin, whose report we noticed in our issue of last week, deals with the climatological observations over the whole Empire, in co-operation with the various States of Germany; while the Hamburg Office deals with everything appertaining to maritime meteorology, including storm warnings, and for this purpose has under its control a number of independent stations, especially along the sea coasts. In carrying out these objects, Dr. Neumayer has the assistance of Drs. Köppen, van Bebber and other well-known men of science. In glancing through the report, one is at once struck by the persistent and successful endeavours to collect observations made at sea; the complete logs and abstract books received during the year from the ships of the Navy and Mercantile Marine numbered no less than 818. For the supply of log-books the consuls in various parts of the world, including this country, act as agents of the Seewarte. The results are published in valuable tables and charts, which are frequently referred to in these columns. For the purpose of issuing weather forecasts and storm warnings the institution is in daily telegraphic communication with all the meteorological services of Europe; upwards of 3000 telegraphic storm warnings were issued to various stations during the year 1899, and the daily and ten-daily weather reports furnish most trustworthy and useful information, the latter relating to weather conditions over an area extending from North America across the North Atlantic, and far into the continent of Asia.

SOME interesting particulars respecting the growth of the acetylene gas industry are given in a recent report by the British Consul at Stuttgart. Calcium carbide has been known to chemists as an interesting chemical compound for several years, but until recently it was practically unknown to the public. Now its production is one of the most important chemical industries. Germany was foremost to recognise the new illuminant, and it has secured the principal place in its production. At present there are at least 200,000 jets of acetylene gas in use in the country, and it is, the Consul says, impossible to predict the result of the competition between it and its rival illuminants. Probably petroleum will suffer most; coal gas will be superseded to a great extent, especially in lighting small towns, but electricity will not be appreciably affected. No other branch of industry can point to such a large and steady increase in the number of patents, showing that it has encouraged great fertility of invention. Besides producing it at home, German capital has gone abroad to produce carbide, especially to Norway and Switzerland. One of the greatest successes of the industry has been its application to the lighting of railway carriages on German Government lines. During the current year the consumption of carbide in the country is estimated at 17,000 tons, equal in illuminating power to about seven millions of gallons of petroleum. Thirty-two small towns, with populations up to 5000, are lighted by acetylene, and many more contemplate its adoption; and the progress of the system of lighting, says the Consul, is "another striking instance of the manner in which the magnificent system of technical education has prepared the way for the introduction of new scientific achievements." The economic importance of the industry appears from the fact that Germany annually pays about five millions sterling to the United States for petroleum, while acetylene is a purely German industry, carbide being manufactured in the country, which possesses in various parts all the necessary raw materials.

WE have received a copy of an illustrated memoir by Signor Rina Monti, published in the *Memorie* of the Royal Institute of Lombardy (vol. xix. pt. i.), detailing the results of experiments on the power of regeneration displayed by marine planarians. It was found that if one of these creatures was cut into two or more portions by transverse section, as many complete individuals were produced.

To the November number of the *Zoologist* Mr. A. H. Meiklejohn contributes a paper on the origin and meaning of the names of British birds, a subject which, according to the author, has hitherto received but little attention. "In most birds' names," he writes, "special stress is invariably laid on some well-known or easily distinguished peculiarity either in cry, flight or appearance." Names from the cry, such as pipit, crake, cuckoo, hoopoe and kittiwake, are especially numerous. To the origin of some, like gull, auk and garganey, there is no clue.

SINCE the publication, some years ago, by Prof. D'Arcy Thompson, of a paper on the affinities of the Eocene American cetacean, commonly known as Zeuglodon, very little advance in our knowledge of the genus has taken place. It is, therefore, satisfactory to find Mr. F. A. Lucas, in the *Proceedings* of the U.S. Museum (vol. xxiii. pp. 327–331), giving an account of the pelvis and

thigh-bone. Both these bones are relatively small, and in life were probably completely buried in the flesh. Although the relationship may be remote, the author considers that Zeuglodon was certainly related to the seals; adding that it probably represents a side branch of the ceto-phocic stock which left no descendants. It is also mentioned that the abundance of its remains in certain districts of the United States has been much exaggerated.

PROF. W. A. HERDMAN has drawn up a scheme of investigations for submission to the Committee of the Lancashire and Western Sea Fisheries. These investigations, it is suggested, should be carried out systematically by the Committee's new steamer, commencing with the new year. The questions as to whether a particular fishery is on the wane or the increase, or whether "nurseries" are already overstocked with young fish or stand in need of replenishing by artificially hatched fish, can only, according to Prof. Herdman, be solved by means of accurate information connected with the abundance, movements and life-histories of the species of fish concerned; and such information can only be acquired by a practical scientific investigation of our seas. The tables drawn up for recording the observations taken during each cruise seem admirably adapted for their purpose. It is proposed that a certain amount of the steamer's time should be devoted to the taking of regular periodic observations at fixed points according to the plan of these tables.

WE have received from the publishers, Messrs. Gurney and Jackson, a copy of the second edition of Mr. H. Goss's valuable pamphlet on the "Geological Antiquity of Insects," the first edition of which was noticed in these columns. In the preface the author expresses regret that he has had neither time nor energy to incorporate the new matter which has been published since the appearance of the first edition, so that the present issue is mainly a reprint of the latter.

MR. A. S. PACKARD describes some tracks of Crustaceans found in rocks of the Chemung stage (Upper Devonian), and in upper Carboniferous of Pennsylvania and elsewhere (*Proc.* Amer. Acad., July 1900). These tracks he attributes to Limuloids akin to the Carboniferous genus Prestwichia. Mr. Packard also describes a new fossil crab (*Cancer proavitus*), from the Miocene of Gay Head, Martha's Vineyard. He remarks that the extinct species appears to be the stem or ancestral form from which have descended the two species now living in the waters of Vineyard Sound.

THE geological section of the Leicester Literary and Philosophical Society is doing excellent work under the chairmanship of Mr. H. Alfred Roechling. Excursions have this year been made to Atherstone, Polesworth, Ashby-de-la-Zouch and other places, concerning which concise reports have been printed, together with sections and geological maps (on a scale of two inches to a mile). These maps and sections are the work of Mr. C. Fox Strangways, who has acted as geological leader on many of the excursions.

IN the *Astrophysical Journal* (vol. xii. pp. 167–175), Prof. H. Crew describes some very interesting experiments he has recently made on the differences in the spectra of various metals when the arc producing the light was surrounded by ordinary air or hydrogen. The investigation was undertaken in the hope that the new condition might have some selective effect on the spectrum lines, and thereby facilitate their grouping into series. The arc was produced in a brass hood made in two halves; into one of these the two electrodes were fitted by insulated bearings, provision being made for one of the electrodes being rotated from outside. The opposing edges of the two hemispheres were then screwed together, and a gas-tight joint obtained. Opposite the space between the poles, the hood was provided with an opening carrying a brass tube some 12 inches long, having at its outer end a quartz lens which served to project an image of the enclosed arc on to the slit of a concave Rowland spectrograph of 10-feet radius. The hydrogen was supplied from three large electrolytic cells, and, after passing through a drying tube, was allowed to continually pass through the brass hood, the surplus being ignited at a stopcock. The first indication of the effect of the hydrogen was to materially diminish its intensity, so much so that in some cases the exposure had to be from five to one hundred times that necessary in air only. In addition, there is a most conspicuous change of relative intensity among the lines of any one substance. Tables are given of the lines affected in the cases of magnesium, zinc and iron. In magnesium, the characteristic line at $\lambda 4481$ has an intensity in hydrogen ten times as great as in air, this change being similar to that obtained in passing from the arc to the induction spark. In the case of iron many lines are greatly enhanced in intensity, but these are not the same lines which are enhanced in substituting the spark for the arc condition; but the author states that all lines in the arc spectrum which are affected by the hydrogen atmosphere, whether enhanced or diminished in intensity, belong to the spark spectrum also. On the other hand, the lines which belong to Kayser and Runge's series are unaffected by the change from air to hydrogen.

MESSRS. PERKEN, SON AND CO., LTD., have just issued a new catalogue of photographic apparatus, magic lanterns and accessories.

FOLLOWING the example of Cornell University, the New Mexico Normal University has commenced the publication of instructive bulletins to encourage interest in nature study. The subjects of the first two bulletins are house-flies and pigments.

IN his letter on the optics of acuteness of sight (p. 83), Dr. A. S. Percival pointed out that as the angle subtended by Jupiter's edge and his first satellite at the observer's eye is greater than one and a half minutes of arc, there is no reason why the four satellites should not be seen by the naked eye. The angle is 1′33″, and not 1·33″ as it was printed.

WE have received from the firm of Gebrüder Borntraeger, Berlin (London: Williams and Norgate), the second fasciculus of the second volume of "Symbolae Antillanae seu fundamenta Florae Indiae occidentalis," edited by Herr J. Urban. The new part deals with the Cyperaceæ, Acanthaceæ, new Lauraceæ and Bromeliaceæ, and new and little known Leguminosae.

PROF. CORFIELD'S Harveian lectures on "Disease and Defective House Sanitation," of which translations into French and Hungarian have already been published by the Royal Society of Public Health of Belgium and the Hungarian Society of Public Health respectively, have now been translated into Italian by Dr. Soffiantini, of Milan, and are being published, with illustrations, in *Il Monitore Tecnico*.

MESSRS. J. AND A. CHURCHILL have published a fourth edition of Dr. E. H. Starling's "Elements of Human Physiology." As an introduction to the larger text-books the volume is admirable, and it has proved a serviceable guide to many students since the original volume was published in 1892. A review of the book appeared in NATURE eight years ago (vol. xlvii. p. 146), and we are glad to know that the merits which have made it successful were then fully recognised.

THE second fasciculus of the first volume of the "Conspectus florae graecae," by Dr. E. de Halácsy, has been published by Mr. W. Englemann, of Leipzig (London: Williams and Norgate). Nearly a century has elapsed since the appearance of

Sibthorp and Smith's "Prodromus florae graecae," and other works on the subject have been issued; but the conspectus now in course of publication will be the first attempt to give anything like a complete account of the flora of Greece, inclusive of Epirus, Crete and neighbouring islands. The work will be entirely in Latin, and will be completed in from eight to ten parts, each of about 160 pages. It is estimated that about five years will elapse before the last part has appeared.

A fifth edition, rewritten and enlarged, of the "Handbook of Practical Botany," translated by Prof. W. Hillhouse from Prof. Strasburger's "Praktikum," has been published by Messrs. Swan Sonnenschien and Co., Ltd. The translation is based upon the third German edition of Prof. Strasburger's well-known work, issued in 1897. A number of new figures have been added, and the notes introduced by Prof. Hillhouse in earlier editions have now been incorporated in the text. The bibliographical notes formerly appended to the chapters have been omitted. For nearly fourteen years Prof. Hillhouse's translation of Prof. Strasburger's text-book has been in use in botanical laboratories, and has shown many students the way to become acquainted with the broad facts of scientific structural botany and the methods of microscopical work. In its revised form the book will be welcomed by all who are interested in the practical study of botany.

The publication of a bibliography, guide and index to bacteriological literature has been commenced in *The Scientific Roll*, conducted by Mr. Alexander Ramsay. The first title included in the part of the general bibliography just issued is "Arcana naturæ detecta," by Leeuwenhoek (1680), and the list extends to 1875 and includes one hundred and one papers published in that year. The works are arranged alphabetically, according to authors. Though the list is not exhaustive it will provide people interested in bacteria with a ready means of finding what has been published on bacteriological subjects, and of tracing the growth of the science. Mr. Ramsay invites authors to send him copies of their papers so that he may make the bibliography as complete as possible. The publisher of the list is Mr. R. L. Sharland, 38, Churchfield-road, Acton, London, W.

A work of interest to students of ethnology, containing the results of the journey to Algeria made by Messrs. D. Randall-MacIver and A. Wilkins, is about to be published by Messrs. Macmillan and Co., under the title of "Libyan Notes." The object of the expedition was to establish if possible any trace of a connection between the Berber tribes and Egypt—a trace finally discovered in the pottery of the Kabyles—but incidentally the writers undertook and recorded a general investigation of the indigenous white race of Northern Africa known to Rome as the Numidians, Gœtulians or Mauri—who figure as a white race on Egyptian monuments as far back probably as 1300 B.C. Thus in addition to the special chapters on the Kabyle pottery and the evidences of a Libyo-Egyptian connection, the book will contain remarks on the Berber history, their language, their interesting political and social organisation; detailed descriptions both of the Aurès and Kabylia, their inhabitants and the local industries; observations and statistics on the physical type of the Berbers based on measurements; and finally some account of the rude stone monuments of Algeria.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mrs. Henry Lazarus; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. H. A. Loop; an Egyptian Jerboa (*Dipus aegyptius*) from North Africa, presented by Mr. K. Riccardo; four Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by Mr. J. E. Matcham; an African Civet Cat (*Viverra civetta*) from West Africa, presented by Mr. R. H. Brady; a Puffin (*Fratercula arctica*), European, presented by Mr. E. T. Norris; a Common Roe (*Capreolus caproea*, albino), European; a One-wattled Cassowary (*Casuarius uniappendiculatus*) from New Guinea, a Yellow-rumped Parrakeet (*Platycercus flaveolus*) from Queensland, an Ocellated Monitor (*Varanus ocellatus*) from East Africa, five Blue Lizards (*Gerrhonotus coeruleus*) from Western North America, three Undulated Lizards (*Sceloporus undulatus*) from South-east United States, deposited; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in December.

Dec. 4. 18h. 41m. to 18h. 45m. Moon occults 13 Tauri (mag. 5·4).
5. 6h. 11m. to 6h. 46m. Moon occults ω^2 Tauri (mag. 4·6).
5. 16h. 5m. to 17h. 0m. Moon occults DM + 20°, 785 (mag. 5·8).
7. 15h. Mercury at greatest elongation, 20° 50′ W.
8. 13h. 32m. to 14h. 37m. Moon occults DM + 17° 1596 (mag. 5·6).
10. 8h. 56m. to 9h. 52m. Moon occults κ Cancri (mag. 5·0).
10–12. Epoch of Geminid meteoric shower (Radiant 108° + 33°).
11. 12h. 36m. Minimum of Algol (β Persei).
12. 13h. Mars in conjunction with moon. Mars 8° 26′ N.
13. 21h. Jupiter in conjunction with the sun.
14. 9h. 25m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·836.
Mars. ,, ,, ,, = 0·907.
16. Saturn. Outer minor axis of outer ring = 15″·40.
17. 6h. 14m. Minimum of Algol (β Persei).
18. 19h. Venus in conjunction with the moon. Venus 2° 19′ N.
19. 16h. Neptune in opposition to the sun.
20. 0h. Mercury in conjunction with moon. Mercury 0° 2′ N.
26. Eros makes nearest approach to the earth.
26. 7h. 42m. to 8h. 33m. Moon occults 51 Aquarii (mag. 5·8).
29. 1h. Saturn in conjunction with sun.

New Variable Stars.—*Cygnus.*—Herr T. Köhl, writing from an observatory at Odder, Denmark, to the *Astronomische Nachrichten* (Bd. 154, No. 3673), draws attention to the variability of the star B.D. + 46°·2970, whose co-ordinates are

$$\left.\begin{array}{l}\text{R.A.} = 20\text{h. } 28\text{m. } 33{\cdot}7\text{s.}\\ \text{Decl.} = +46^\circ\ 4'{\cdot}2\end{array}\right\}(1855).$$

A note by Herr E. Hartwig suggests that the period of this variable is more than a year.

Aquila.—Dr. T. D. Anderson, in the same journal, announces the variability of the star B.D. + 9°·4205, having the position

$$\left.\begin{array}{l}\text{R.A.} = 19\text{h. } 33\text{m. } 48{\cdot}2\text{s.}\\ \text{Decl.} = +9^\circ\ 35'{\cdot}4\end{array}\right\}(1855).$$

Using four neighbouring stars for comparison, the following values were obtained:—

	Mag.
1900 Sept. 18 =	9·2
24 =	9·2
Oct. 1 =	9·4
25 =	10·0
Nov. 9 =	10·6

Pegasus.—Dr. Anderson also finds the star A.G. Leipzig I. 8381 to be variable. Its position is

$$\left.\begin{array}{l}\text{R.A.} = 21\text{h. } 6\text{m. } 15{\cdot}0\text{s.}\\ \text{Decl.} = +12^\circ\ 12'\ 26''\end{array}\right\}(1855).$$

The following estimations of its magnitude have been made:—

	Mag.
1900 Sept. 26 =	9·1
Oct. 27 =	9·5
Nov. 10 =	10·1

EPHEMERIS FOR OBSERVATIONS OF EROS.—The following abridged ephemeris will serve for finding the planet during the month of December :—

Ephemeris for 12*h*. *Berlin Mean Time*.

1900.		R.A. h. m. s.		Decl. ° ′ ″
Dec. 1	...	1 27 19·27	...	+50 23 49·6
3	...	26 42·70	...	49 43 44·9
5	...	26 33·12	...	49 1 40·7
7	...	26 50·26	...	48 17 51 2
9	...	27 33 77	...	47 32 28·9
11	...	28 43·13	...	46 45 46·0
13	...	30 17·82	...	45 57 53·5
15	...	32 17·24	...	45 9 2·7
17	...	34 40·66	...	44 19 24·0
19	...	37 27·28	...	43 29 7·2
21	...	40 36·30	...	42 38 20·6
23	...	44 6·85	...	41 47 12·2
25	...	47 57·92	...	40 55 49·0
27	...	52 8·49	...	40 4 17·1
29	...	1 56 37·43	...	39 12 40·8
31	...	2 1 23·61	...	+38 21 3·0

DISTRIBUTION OF MINOR PLANETS.—M. Freycinet has a further article in the *Comptes rendus* (vol. cxxxi. pp. 815-821), in which he discusses the distribution of the zone of asteroids more critically than in his previous paper in *Comptes rendus*, cxxx. pp. 1145-1154. On the assumption that these small bodies are the product of disruption of a former ring of matter revolving round the central body, he calculated the mean eccentricities of the several rings into which it might be expected to divide. On examination of the elements of 428 of the planets, it has been possible to divide them into eight groups, the members of each group having similar eccentricity and inclination of orbit. The numbers of separate bodies in each zone vary greatly—from 1 to 170. The mean thickness of the rings is 0·278, the radius of the earth's orbit being taken as unit, the individual rings varying from 0·22 to 0·36. In each ring the mean eccentricity of the members situated in the inner or inferior half is greater than that of the members occupying the superior or outer half; and comparing two rings, it is found that the mean eccentricity of the planets in the inferior part of the outer ring is greater than that of those occupying the superior part of the inner ring. In one ring—the fifth—consisting of 69 planets, the mean eccentricities of the two halves are identical, and it will be interesting to examine the places occupied by asteroids discovered in the future as to their effect on the constants of this region of the swarm.

THE NOVEMBER METEORS.—In the *Comptes rendus* (vol. cxxxi. pp. 821-825) Dr. Janssen describes the special preparations made for observing, from balloons, the meteors expected during the past month. A few Leonids were seen, but no indication of any special fall. In the description of the ascents, mention is made of the observers having to pass through several cloud belts, suggesting that in future an altitude of some 6000 metres should be attained to ensure more certainty of a clear sky.

M. Deslandres also gives, in the same issue (pp. 826-7), the results of the observations made at the Meudon Observatory. They were both visual and photographic, the latter being made with six cameras having apertures from 6 to 2 inches. All were carried by a single equatorial mounting so as to be under the control of one observer.

On the night of November 14, from 9h. 30m. to 1h., traces of 16 meteors were secured, of which 6 were Leonids, 5 Andromedes and 2 sporadie. On the night of the 15th, after 9h. 30m. 5 traces were obtained, 3 of which were Leonids.

HUXLEY'S LIFE AND WORK.[1]

II.

ANOTHER remarkable side of Huxley's mind was his interest in and study of metaphysics. When the Metaphysical Society was started in 1869, there was some doubt among the promoters whether Huxley and Tyndall should be invited to join or not. Mr. Knowles was commissioned to come and consult me. I said at once that to draw the line at the opinions which they were known to hold would, as it seemed to me, limit the field of discussion, and there would always be doubts as to when the forbidden region began ; that I had understood there was to be perfect freedom, and that though Huxley's and Tyndall's views might be objectionable to others of our members, I would answer for it that there could be nothing in the form of expression of which any just complaint could be made.

The society consisted of about forty members, and when we consider that they included Thompson, Archbishop of York, Ellicott, Bishop of Gloucester and Bristol, Dean Stanley and Dean Alford as representatives of the Church of England ; Cardinal Manning, Father Dalgairns and W. G. Ward as Roman Catholics ; among statesmen, Gladstone, the late Duke of Argyll, Lord Sherbrooke, Sir M. Grant Duff, John Morley, as well as Martineau, Tennyson, Browning, R. H. Hutton, W. Bagehot, Frederic Harrison, Leslie Stephen, Sir J. Stephen, Dr. Carpenter, Sir W. Gull, W. R. Greg, James Hinton, Shadworth Hodgson, Lord Arthur Russell, Sir Andrew Clark, Sir Alexander Grant, Mark Patteson, and W. K. Clifford, it will not be wondered that I looked forward to the meetings with the greatest interest. I experienced also one of the greatest surprises of my life. We all, I suppose, wondered who would be the first President. No doubt what happened was that Roman Catholics objected to Anglicans, Anglicans to Roman Catholics, both to Nonconformists ; and the different schools of metaphysics also presented difficulties, so that finally, to my amazement, I found myself the first President ! The discussions were perfectly free, but perfectly friendly ; and I quite agree with Mr. H. Sidgwick, that Huxley was one of the foremost, keenest and most interesting debaters, which, in such a company, is indeed no slight praise.

We dined together, then a paper was read, which had generally been circulated beforehand, and then it was freely discussed, the author responding at the close. Huxley contributed several papers, but his main contribution to the interest of the Society was his extraordinary ability and clearness in debate.

His metaphysical studies led to his work on Hume and his memoirs on the writings of Descartes.

One of his most interesting treatises is a criticism of Descartes theory of animal automatism. Descartes was not only a great philosopher, but also a great naturalist, and we owe to him the definite allocation of all the phenomena of consciousness to the brain. This was a great step in science, but, just because Descartes' views have been so completely incorporated with everyday thought, few of us realise how recently it was supposed that the passions were seated in the apparatuses of organic life. Even now we speak of the heart rather than the brain in describing character.

Descartes, as is known, was much puzzled as to the function of one part of the brain—a small, pear-shaped body about the size of a nut, and deeply seated. Known as the pineal gland, he suggested that it was the seat of the soul ; but it is now regarded, and apparently on solid grounds, as the remains of the optic lobe of a central eye once possessed by our far-away ancestors, and still found in some animals, as, for instance, in certain lizards. Descartes was much impressed by the movements which are independent of consciousness or volition, and known as reflex actions—such, for instance, as the winking of the eye or the movement of the leg if the sole of the foot is touched. This takes place equally if, by any injury to the spinal marrow, the sensation in the legs has been destroyed.

Such movements appear to be more frequent among lower animals, and Descartes supposed that all their movements might be thus accounted for—that they were, like the movements of sensitive plants, absolutely detached from consciousness or sensation, and that, in fact, animals were mere machines or automata, devoid not only of reason, but of any kind of consciousness.

It must be admitted that Descartes' arguments are not easy to disprove, and no doubt certain cases of disease or injury—as, for instance, that of the soldier described by Dr. Mesnet, who, as the result of a wound in the head, fell from time to time into a condition of unconsciousness, during which, however, he ate, drank, smoked, dressed and undressed, and even wrote—have supplied additional evidence in support of his views. Huxley, while fully admitting this, came, and I think rightly, to the conclusion that the consciousness of which we feel certain in ourselves must have been evolved very gradually, and must therefore exist, though probably in a less degree, in other animals.

[1] The first "Huxley Memorial Lecture" of the Anthropological Institute, delivered on November 13, by the Rt. Hon. Lord Avebury, F.R.S., D.C.L., LL.D. Continued from p. 96.

No one, indeed, I think, who has kept and studied pets, even if they be only ants and bees, can bring himself to regard them as mere machines.

The foundation of the Metaphysical Society led to the invention of the term "Agnostic."

"When I reached intellectual maturity," Huxley tells us, "and began to ask myself whether I was an atheist, a theist or a pantheist, a materialist or an idealist, a Christian or a freethinker, I found that the more I learned and reflected, the less ready was the answer; until, at last, I came to the conclusion that I had neither art nor part with any of these denominations except the last. The one thing in which most of these good people were agreed was the one thing in which I differed from them. They were quite sure they had attained a certain "gnosis"—had, more or less successfully, solved the problem of existence; while I was quite sure I had not, and had a pretty strong conviction that the problem was insoluble . . . ."

These considerations pressed forcibly on him when he joined the Metaphysical Society.

"Every variety," he says, "of philosophical and theological opinion was represented there, and expressed itself with entire openness; most of my colleagues were "ists" of one sort or another; and, however kind and friendly they might be, I, the man without a rag of a habit to cover himself with, could not fail to have some of the uneasy feelings which must have beset the historical fox when, after leaving the trap, in which his tail remained, he presented himself to his normally elongated companions. So I took thought, and invented what I conceived to be the appropriate title of agnostic. It came into my head as suggestively antithetic to the gnostic of Church history, who professed to know so much about the very things of which I was ignorant; and I took the earliest opportunity of parading it at our Society, to show that I, too, had a tail like the other foxes."

Huxley denied that he was disposed to rank himself either as a fatalist, a materialist, or an atheist. "Not among fatalists, for I take the conception of necessity to have a logical, and not a physical, foundation; not among materialists, for I am utterly incapable of conceiving the existence of matter if there is no mind in which to picture that existence; not among atheists, for the problem of the ultimate cause of existence is one which seems to me to be hopelessly out of reach of my poor powers."

The late Duke of Argyll, in his interesting work on "The Philosophy of Belief," makes a very curious attack on Huxley's consistency. He observes that scientific writers use "forms of expression as well as individual words, all of which are literally charged with teleological meaning. Men even who would rather avoid such language if they could, but who are intent on giving the most complete and expressive description they can of the natural facts before them, find it wholly impossible to discharge this duty by any other means. Let us take as an example the work of describing organic structures in the science of biology. The standard treatise of Huxley on the 'Elements of Comparative Anatomy,' affords a remarkable example of this necessity, and of its results. . . .

"How unreasonable it is to set aside, or to explain away, the full meaning of such words as 'apparatuses' and 'plans,' comes out strongly when we analyse the preconceived assumptions which are supposed to be incompatible with the admission of it. . . .

"To continue the use of words because we are conscious that we cannot do without them, and then to regret or neglect any of their implications, is the highest crime we can commit against the only faculties which enable us to grasp the realities of the world." Is not this, however, to fall into the error of some Greek philosophers, and to regard language, not only as a means of communication, but as an instrument of research. We all speak of sunrise and sunset, but it is no proof that the sun goes round the earth. The Duke himself says elsewhere:—

"We speak of time as if it were an active agent in doing this, that and the other. Yet we are quite conscious, when we choose to think of it, that when we speak of time in this sense, we are really thinking and speaking, not of time itself, but of the various physical forces which operate slowly and continuously in, or during, time. Apart from these forces, time does nothing."

This is, it seems to me, a complete reply to his own attack on Huxley's supposed inconsistency.

Theologians often seem to speak as if it were possible to believe something which one cannot understand, as if the belief were a matter of will, that there was some merit in believing what you cannot prove, and that if a statement of fact is put before you, you must either believe or disbelieve it. Huxley, on the other hand, like most men of science, demanded clear proof, or what seemed to him clear proof, before he accepted any conclusion; he would, I believe, have admitted that you might accept a statement which you could not explain, but would have maintained that it was impossible to believe what you did not understand; that in such a case the word "belief" was an unfortunate misnomer; that it was wrong, and not right, to profess to believe anything for which you knew that there was no sufficient evidence, and that if it is proved you cannot help believing it; that as regards many matters the true position was not one either of belief or of disbelief, but of suspense.

In science we know that though the edifice of fact is enormous, the fundamental problems are still beyond our grasp, and we must be content to suspend our judgment, to adopt, in fact, the Scotch verdict of "not proven," so unfortunately ignored in our law as in our theology.

Faith is a matter more of deeds, not of words, as St. Paul shows in the Epistle to the Hebrews. If you do not act on what you profess to believe, you do not really and in truth believe it. May I give an instance? The Fijians really believed in a future life, according to their creed, you rose in the next world exactly as you died here—young if you were young, old if you were old, strong if you were strong, deaf if you were deaf, and so on. Consequently it was important to die in the full possession of one's faculties, before the muscles had begun to lose their strength, the eye to grow dim, or the ear to wax hard of hearing. On this they acted. Every one had himself killed in the prime of life; and Captain Wilkes mentions that in one large town there was not a single person over forty years of age.

That I call faith. That is a real belief in a future life.

Huxley's views are indicated in the three touching lines by Mrs. Huxley, which are inscribed on his tombstone:—

Be not afraid, ye wailing hearts that weep,
For still He giveth His beloved sleep,
And if an endless sleep He wills—so best.

That may be called unbelief, or a suspension of judgment. Huxley doubted.

But disbelief is that of those who, no matter what they say, act as if there was no future life, as if this world was everything, and in the words of Baxter in "The Saints' Everlasting Rest," profess to believe in Heaven, and yet act as if it was to be "tolerated indeed rather than the flames of Hell, but not to be desired before the felicity of Earth."

Huxley was, indeed, by no means without definite beliefs. "I am," he said, "no optimist, but I have the firmest belief that the Divine Government (if we may use such a phrase to express the sum of the 'customs of matter') is wholly just. The more I know intimately of the lives of other men (to say nothing of my own), the more obvious it is to me that the wicked does not flourish nor is the righteous punished."

One of the great problems of the future is to clear away the cobwebs which the early and mediæval ecclesiastics, unavoidably ignorant of science, and with ideas of the world now known to be fundamentally erroneous, have spun round the teachings of Christ; and in this Huxley rendered good service. For instance, all over the world in early days lunatics were supposed to be possessed by evil spirits. That was the universal belief of the Jews, as of other nations, 2000 years ago, and one of Huxley's most remarkable controversies was with Mr. Gladstone and Dr. Wace with reference to the "man possessed with devils," which, we are told, were cast out and permitted to enter into a herd of swine. Some people thought that these three distinguished men might have occupied their time better than, as was said at the time, "in fighting over the Gaderene swine." But as Huxley observed:—

"The real issue is whether the men of the nineteenth century are to adopt the demonology of the men of the first century as divinely-revealed truth, or to reject it as degrading falsity."

And as the first duty of religion is to form the highest conception possible to the human mind of the Divine Nature, Huxley naturally considered that when a Prime Minister and a Doctor of Divinity propound views showing so much ignorance of medical science, and so low a view of the Deity, it was time that a protest was made in the name, not only of science, but of religion.

Theologians themselves, indeed, admit the mystery of existence. "The wonderful world," says Canon Liddon, "in which we now pass this stage of our existence, whether the higher world

of faith be open to our gaze or not, is a very temple of many and august mysteries. . . . Everywhere around you are evidences of the existence and movement of a mysterious power which you can neither see, nor touch, nor define, nor measure, nor understand."

One of Huxley's difficulties he has stated in the following words: "Infinite benevolence need not have invented pain and sorrow at all—infinite malevolence would very easily have deprived us of the large measure of content and happiness that falls to our lot."

This does not, I confess, strike one as conclusive. It seems an answer—if not perhaps quite complete, that if we are to have any freedom and responsibility, the possibility of evil follows necessarily. If two courses are open to us, there are two alternatives; either the results are the same in either case, and then it does not matter what we do; or the one course must be wise and the other unwise. Huxley, indeed, said in another place:—"I protest that if some great power could agree to make me always think what is true, and do what is right, on condition of being turned into a sort of clock and wound up every morning before I got out of bed, I should instantly close with the offer. The only freedom I care about is the freedom to do right; the freedom to do wrong I am ready to part with on the cheapest terms to any one who will take it of me. But when the Materialists stray beyond the borders of their path, and talk about there being nothing else in the world but Matter and Forces and necessary laws, ... I decline to follow them."

Huxley was no enemy to the existence of an Established Church.

"I could conceive," he said, "the existence of an Established Church which should be a blessing to the community. A church in which, week by week, services should be devoted, not to the iteration of abstract propositions in theology, but to the setting before men's minds of an ideal of true, just and pure living; a place in which those who are weary of the burden of daily cares should find a moment's rest in the contemplation of the higher life which is possible for all, though attained by so few; a place in which the man of strife and of business should have time to think how small, after all, are the rewards he covets compared with peace and charity. Depend upon it, if such a Church existed, no one would seek to disestablish it."

It seems to me that he has here very nearly described the Church of Stanley, of Jowett, and of Kingsley.

Sir W. Flower justly observed that while "if the term 'religious' be limited to acceptance of the formularies of one of the current creeds of the world, it cannot be applied to Huxley; but no one could be intimate with him without feeling that he possessed a deep reverence for 'whatsoever things are true, whatsoever things are honest, whatsoever things are just, whatsoever things are pure, whatsoever things are lovely, whatsoever things are of good report,' and an abhorrence of all that is the reverse of these; and that, although he found difficulty in expressing it in definite words, he had a pervading sense of adoration of the infinite, very much akin to the highest religion."

Lord Shaftesbury records that "Prof. Huxley has this definition of morality and religion:—'Teach a child what is wise, that is morality. Teach him what is wise and beautiful, that is religion!' Let no one henceforth despair of making things clear and of giving explanations!" ("Life and Works," iii. 282).

I doubt, indeed, whether the debt which Religion owes to Science has yet been adequately acknowledged.

The real conflict—for conflict there has been and is—is not between Science and Religion, but between Science and Superstition. A disbelief in the goodness of God led to all the horrors of the Inquisition. Throughout the Middle Ages and down almost to our own times, as Lecky has so powerfully shown, the dread of witchcraft hung like a black pall over Christianity. Even so great and good a man as Wesley believed in it. It is Science which has cleared away these dark clouds, and we can hardly fail to see that it is just in those countries where Science is most backward that Religion is less well understood, and in those where Science is most advanced that Religion is purest. The services which Science has rendered to Religion have not as yet, I think, received the recognition they deserve.

Many of us may think that Huxley carried his scepticism too far, that some conclusions which he doubted, if not indeed proved, yet stand on a securer basis than he supposed.

He approached the consideration of these awful problems, however, in no scoffing spirit, but with an earnest desire to arrive at the truth, and I am glad to acknowledge that this has been generously recognised by his opponents.

From his own point of view, Huxley was no opponent of religion, however fundamentally he might differ from the majority of clergymen. In Science we differ, but we are all seeking for truth, and we do not dream that any one is an enemy to "science."

In Theology, however, unfortunately as we think, a different standard has been adopted. Theologians often, though no doubt there are many exceptions, regard a difference from themselves as an attack on religion, a suspension of judgment as an adverse verdict, and doubt as infidelity.

It is therefore only just to them to say that their obituary notices of Huxley were fair and even generous. When they treated him as a foe they did so, as a rule, in a spirit as honourable to them as it was to him.

The *Christian World*, in a very interesting obituary notice, truly observed that "if in Huxley's earlier years the average opinion of the churches had been as ready as it is now to accept the evolution of the Bible, it would not have been so startled by Darwin's theory of the evolution of man; and Darwin's greatest disciple would have enjoyed thirty years ago the respect and confidence and affection with which we came to regard him before we lost him."

"Surely it is a striking and suggestive fact that both the retiring and the incoming President of the Royal Society, by way of climax to their eulogies, dwelt on the religious side of Huxley's character. "If religion means strenuousness in doing right, and trying to do right, who," asked Lord Kelvin, "has earned the title of a religious man better than Huxley?" And similarly Sir J. Lister, in emphasising Huxley's intellectual honesty, "his perfect truthfulness, his whole-hearted benevolence," felt impelled to adopt Lord Kelvin's word and celebrate "the religion that consists in the strenuous endeavour to be and do what is right."

Huxley was not only a great man, but a good and a brave one. It required much courage to profess his opinions, and if he had consulted only his own interests he would not have done so, but we owe much to him for the inestimable freedom which we now enjoy.

When he was moved to wrath it was when he thought wrong was being done, the people were being misled, or truth was being unfairly attacked, as, for instance, in the celebrated discussion at Oxford. The statue in the Natural History Museum is very powerful and a very exact likeness, but it is like him when he was moved to righteous indignation. It is not Huxley as he was generally, as he was when he was teaching, or when in the company of friends. He was one of the most warm-hearted and genial of men. Mr. Hutton, who sat with him on the Vivisection Commission, has recorded that "considering he represented the physiologists on this Commission, I was much struck with his evident horror of anything like torture even for scientific ends." I do not, however, see why this should have surprised him, because the position of physiologists is that it is the anti-vivisectionists who would enormously increase the suffering in the world. To speak of inflicting pain "for scientific ends" is misleading. It is not for the mere acquisition of useless knowledge, but for the diminution of suffering and because one experiment may prevent thousands of mistakes and save hundreds of lives. The medical profession may be mistaken in this, but it is obvious that their conviction, whether it be right or whether it be wrong, is not only compatible with, but is inspired by, a horror of unnecessary suffering.

The great object of his labours was, in his own words, "to promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life." His family life was thoroughly happy. He was devoted to his children, and they to him. "The love our children show us," he said in one of his letters, "warms our old age better than the sun."

Nor can I conclude without saying a word about Mrs. Huxley, of whom her son justly says that she was "his help and stay for forty years, in his struggles ready to counsel, in adversity to comfort; the critic whose judgment he valued above almost any, and whose praise he cared most to win; his first care and his latest thought, the other self, whose union with him was a supreme example of mutual sincerity and devotion."

At a time of deep depression and when his prospects looked most gloomy he mentions a letter from Miss Heathorn as

having given him "more comfort than anything for a long while. I wish to Heaven," he says, "it had reached me six months ago. It would have saved me a world of pain and error."

Huxley had two great objects in life as he has himself told us. "There are," he said, "two things I really care about—one is the progress of scientific thought, and the other is the bettering of the condition of the masses of the people by bettering them in the way of lifting themselves out of the misery which has hitherto been the lot of the majority of them. Posthumous fame is not particularly attractive to me, but, if I am to be remembered at all, I would rather it should be as 'a man who did his best to help the people' than by any other title."

It is not only because we, many of us, loved him as a friend, not only because we all of us recognise him as a great naturalist, but also because he was a great example to us all, a man who did his best to benefit the people, that we are here to do honour to his memory to-day.

THE ORIGIN AND PROGRESS OF SCIENTIFIC SOCIETIES.[1]

ON the present occasion I propose to say a few words on a subject of little practical importance, so far as the needs of every-day life are concerned, but still not without some general interest, and not without a direct bearing on the history of the advancement of human knowledge—the "Origin, Development and Aims of our Scientific Societies." The subject is a large one, and it will be impossible to enter into details with regard to its almost innumerable ramifications. In justification of a considerable degree of limitation, I may incidentally mention that the "Official Year-book of the Scientific and Learned Societies of Great Britain and Ireland," for the year 1900, extends over upwards of 290 octavo pages.

In England no learned society received a Royal Charter before 1662, when the Royal Society was incorporated by Charles II. It had, however, been instituted in 1660. So early, moreover, as 1645 the lovers of experimental philosophy formed a society which met weekly in London on a certain day to treat and discourse of philosophical affairs, and many of its members became subsequently the first Fellows of the Royal Society. About the year 1648–1649, this little band of students was divided into two—one part remaining in London and the other migrating to Oxford, where a Philosophical Society of Oxford was established that subsequently for some time worked in concert with the Royal Society, and did not finally cease to exist until 1690.

About the year 1572, "divers gentlemen of London, studious in antiquities, formed themselves into a College or Society of Antiquaries." The honour of this foundation is "entirely due to that munificent patron of letters and learned men, Archbishop Parker. The members met near 20 years at the house of Sir Robert Cotton, and, in 1589, resolved to apply to the Queen for a charter of incorporation, and for some public building, where they might assemble and have a library." A petition was prepared for presentation to Her Majesty Queen Elizabeth praying for the incorporation of "An Academy for the Studye of Antiquity and History," the meetings of which were to be held in the Savoy, or the dissolved Priory of St. John of Jerusalem, or elsewhere. It is uncertain whether this petition was ever presented, but the Queen seems to have given the society her countenance, and under the presidency of Archbishops Parker and Whitgift successively it flourished, and a list of thirty-eight of its members, comprising such well-known names as Camden, Cotton, Erdeswicke, Lambarde, and Stow, is still extant. For some cause or other Elizabeth's successor, James I., thought fit to dissolve the society in 1604, and though attempts were made to revive it in 1617, and though there was an Antiquaries' feast on July 2, 1659, the society remained in a dormant condition until 1707. It then held weekly meetings at the "Bear Tavern" in the Strand, and afterwards at the "Young Devil Tavern" in Fleet Street, subsequently moving to the "Fountain Tavern." In 1718 the society was reconstituted, and in 1751 a Charter of Incorporation was granted to it by George II., who declared himself the founder and patron of the Society of Antiquaries of London.

Having traced the inception of the two oldest of our learned societies, which in their early stages partook more of the nature of clubs than of what are now known as societies, I propose, before considering their further developments, to say something as to the proper aims and objects of a learned society, and the means usually adopted for carrying them into effect. Such a society is an association of persons united together by common tastes and anxious to improve or extend some particular branch of knowledge, or even the whole range of scientific inquiry. With this object in view it becomes necessary to hold periodical meetings for the discussion of subjects in which the society is interested, and for taking such action in respect of them as may seem desirable. The holding of such meetings involves an organisation and the appointment of presidents to take the chair at meetings, of secretaries to summon them, and of a treasurer to receive those subscriptions without which an association of the kind cannot exist. Moreover, for the determination of questions of policy and finance, especially when the society issued publications, a council of some kind becomes a necessity. It is on this organisation that the success or failure of a society mainly depends, and the questions as to the length of period that presidents and others should remain in office, what proportion of new blood should be infused into the council each year, and how far those in power are carrying out the views of the bulk of the members of the society, have frequently been discussed with more or less warmth. In some instances the too conservative apathy of the council has led to disruption and the foundation of new societies, or to the society under their charge being reduced to a state of inanimate slumber, while on the other hand too rapid revolutionary measures have led to diminutions in numbers, if not to absolute rebellion. Much, of course, of the welfare of a society depends upon the character of its publications being kept at a high level, and on their being brought out with scrupulous regularity.

There is one condition in the life of a scientific society which is entirely beyond its control or that of its council, and this condition may be superinduced by the activity of the society itself. As researches proceed and knowledge extends, new branches of inquiry are opened, which can only be investigated by those who apply themselves specially to the subject. New publications are required, particular days have to be set apart for the discussion of the new subject, and eventually it is found desirable to establish a separate branch of the old society, or to constitute a new one. The latter course is the one that has been most often adopted, especially in the case of biological science; and not infrequently the new society finds a home in the apartments of the parent society, and under its fostering care.

Let us now go back to the period when Charles II. granted his second Charter to the Royal Society of London for improving natural knowledge. The Society of Antiquaries was in abeyance, so that the Royal Society was practically the only institution of the kind in Britain, and its aims were naturally wide. On November 20, 1663, the society consisted of 131 Fellows, of whom 18 were noblemen, 22 baronets and knights, 47 esquires, 32 doctors, 2 bachelors of divinity, 2 masters of arts, and 8 strangers or foreign members. With the exception of the large proportion of physicians or doctors, it will be observed that the society in the main was composed of noblemen and gentlemen of independent position, and that the professional element was to a very great extent wanting. Great attention was paid to experimental methods; but "what the learned and inquisitive are doing, or have done in physick, mechanicks, opticks, astronomy, medicine, chymistry, anatomy, both abroad and at home" were subjects on which they were solicitous. Many of the branches of science diligently pursued at the present day were either unknown or in their infancy. The variation of the compass had been observed, but magnetism and electricity presented almost untrodden fields; the steam engine was in an embryonic stage; visions of space with four or more dimensions had not visited the poetical mathematical brain; microscopes and telescopes were in their infancy; the family of the planets was no more numerous than of old; the circulation of the blood had not met with universal acceptance, and the existence of *bacilli* was but dimly conceived; chemistry was of the crudest, and the elements were earth, air, fire and water; anatomy had already made notable advances, but Dermatological, Laryngological, and Odontological societies were not even dreamt of; geology was unborn, and palæontology did not exist, except in connection with Noah's Deluge.

One of the results of this very wide scope of the Royal Society was, that at its meeting the variety of subjects brought forward

[1] Abridgment of an address delivered at the opening meeting of the Society of Arts, November 21, by Sir John Evans, K.C.B., F.R.S.

for discussion was great; and the early volumes of the *Philosophical Transactions* contain a large amount of miscellaneous reading. I am not sure that, as a means of whiling away a spare half-hour, one of the first twenty volumes of the *Transactions* would not by most persons be found more attractive and amusing than the volume, say, of Series A for the year 1900.

The Society for the Encouragement of Arts, Manufactures, and Commerce was founded in 1754, but not incorporated until 1847, and this society, together with the two already mentioned, form the trio from which nearly all the numerous learned societies of the present day have sprung, by what may be regarded as a natural process of evolution.

As might have been expected, Scotland was not long in following the example set by England, and the Medical Society of Edinburgh was instituted in 1734, to be followed by the somewhat kindred Harveian Society in 1752. In the meantime, the Royal Society of Edinburgh, or, as it was originally called, the Philosophical Society, was established in 1739. The "Royal Physical Society of Edinburgh," exclusively devoted to "Natural History and the Physical Sciences," was founded in 1771, and by 1813 had absorbed no less than six other societies, which became incorporated in it.

In Ireland, the Royal Irish Academy for "the study of Science, Polite Literature, and Antiquities," was founded in 1785, and may be regarded as combining the attributes of the three parent societies in London.

Among the off-shoots of the Royal Society of London, the first perhaps is the Medical Society, founded in 1773. The Linnean Society, for the cultivation of natural history in all its branches, was founded in 1788, and has from 700 to 800 Fellows. These are the only two London societies coming under this category that date from the last century.

During the century now drawing to its close the vast advances in science, and the innumerable aspects it assumes, has led to the foundation of numerous scientific societies, each with a more or less limited scope. In natural history we have the Horticultural (1804), the Zoological (1826), the Entomological (1833), the Ornithological (1837), the Royal Botanic (1839), the Ray Society (1844), the Palæontographical (1847), and others that it would be tedious to mention.

Geology as a new science had a society founded for its study in 1807, the Geologists' Association followed in 1858, and at a later date the Mineralogical Society (1876). The Royal Astronomical Society (1820) has been supplemented by the British Astronomical Association. Mathematics and Physics have also their own societies, as have also Statistics, a subject which has a mathematical side as well as one in the direction of commerce and the affairs of ordinary life. Engineering is represented, not only by the Institution of Civil Engineers (1818), but by the Institution of Mechanical Engineers (1847), of Mining Engineers (1851), the Iron and Steel Institute (1869), and that of Electrical Engineers (1871). Geography has had its own Royal Society since 1830, Microscopy its society since 1839, and Meteorology since 1850. For medicine, pharmaceutics, pathology, neurology, anatomy, and some other branches of medical inquiry, special societies have been founded in London. The Victoria Institute or Philosophical Society of Great Britain was founded in 1865, its primary object being the attempt to reconcile apparent discrepancies between Christianity and science.

In Edinburgh and Dublin scientific societies have multiplied, though not to a similar extent; and throughout the United Kingdom there are numerous literary and philosophical societies, that of Manchester dating back to 1781. There are also several provincial geological societies, and almost every county has its natural history society or club.

Moreover, the British Association for the Advancement of Science, founded in 1831, continues to hold its annual meetings at different centres in the Empire, and helps to maintain the general interest in the advancement of knowledge and to kindle or keep alive local zeal.

The offshoots from the Society of Antiquaries have not been so numerous or important as those from the Royal Society, the field of Archæology being much more restricted than the wide domain of more purely "natural knowledge." The Society of Antiquaries of Scotland dates, however, from 1780, and that of Newcastle-on-Tyne from 1813, while the Literary and Antiquarian Society of Perth goes back to 1784. Several branches of antiquarian study have now their own societies. The Numismatic Society was founded in 1836, the Royal Historical Society in 1868, the Society of Biblical Archæology in 1871, the Palæontographical in 1873, and that for Hellenic studies in 1879. There are also special societies for the exploration of Palestine and Egypt, as well as the important Royal Asiatic Society with its different branches. The peripatetic habits of the Royal Archæological Institute and of the British Archæological Association (both 1843) help to maintain the warmth of local interest and to disseminate a certain amount of archæological information.

Anthropology and Ethnology have made great advance since the foundation of the Ethnological Society in 1843, and of the Anthropological in 1863. The two merged in 1871 to form the Anthropological Institute, which has rendered signal services to science. A minor branch of anthropology—Folk Lore—has had its own society at work since 1878.

The Society of Arts—to make use of its shortened title—can claim nearly as numerous an offspring as its elder sisters the Royal Society and the Society of Antiquaries. Her descendants, moreover, are fairly entitled to as high, if not indeed a higher, rank and importance. It is not merely the Royal Scottish Society of Arts (1821) that she can claim as an offshoot, but it was the Society of Arts that first in England devoted attention to the all-important objects of forestry and agriculture. The Royal Agricultural Society originated not earlier than 1838, though in Scotland a Society of Improvers of Agriculture was instituted in 1723, a Dublin Agricultural Society in 1731, the Bath and West of England Society in 1777, and the Highland Society in 1784.

It would, moreover, be unfair not to credit the Society of Arts as well as the Royal Society with having laid the foundations on which the Institution of Civil Engineers and the cognate bodies have been erected. The Chemical Society was established at a meeting held at the rooms of the Society of Arts in 1841. From this arose the Institute of Chemistry in 1877. The Society of Chemical Industry (1881) to a large extent grew out of the Chemical Section of the Society of Arts, which dealt for some years with the chemical industries, and was dropped on the foundation of the society. The Sanitary Institute and the other sanitary societies certainly owe their origin to the Conferences on the Health and Sewage of Towns held by the Society of Arts in 1877, 1879, and 1880. The City and Guilds' Institute also originated in consequence of the action of the society in the matter of technical education. They took up and carried on the technological examination founded by the Society of Arts.

It must never be forgotten that in its earlier days inventions of all useful kinds, and all that was new in machinery and manufactures, came within the scope of the society, which in thirty years spent many thousands of pounds in rewards and premiums for useful inventions.

It took a very active part in all educational movements and a warm interest in the welfare of our Colonies, and to its credit be it said that the examinations of the Society of Arts still rank among the most useful and thorough, while the existence of our Indian Section still evinces our interest in the prosperity of the dependencies of the Empire.

What the society has done for the advancement of art, it is difficult for us of the present day fully to appreciate; but it must be remembered that one of the first, if not, indeed, the first public exhibition of pictures was that held in the society's rooms in 1760, and that from this exhibition sprang the Royal Academy, the first exhibition of which, comprising one hundred and thirty-six works only, was opened in 1769. We may, therefore, here claim the Royal Academy as in a certain sense an offshoot from our body. The Royal Institute of British Architects, founded in 1835, may also in some degree be regarded as connected with the Royal Academy, which admits architects among its members. The Photographic Society also grew out of an exhibition of photographs, the first of the kind held in our rooms. The foundation of the Royal College of Music is likewise due to the exertions of the Society of Arts.

It would indeed be difficult to say how far the work done by any society would have been accomplished by the individuals composing that society, without combination or collective organisation. A society of course is only a collection of individuals, and the work of the society is the work of the individuals composing it.

A society offers opportunities for discussion, brings men of similar ideas together, and substitutes collective and organised action for isolated individual effort. It affords means of publication, organises research, records discoveries, stimulates

invention, and assists students by providing a common meeting-place and centre of action. Every scientific discoverer desires immediate publication of his work, both for his own reputation and to secure the assistance of his colleagues. Every industrial inventor requires publication in order that he may secure the natural profits of his invention. A society systematises and arranges the science or study which is its subject-matter.

The present condition of science is certainly due to the organised efforts of such societies as the Royal Society and its subordinate societies in this and other countries. They secure public recognition for science and those who pursue it; they prevent overlapping; serve to deter different men from working on the same lines; and they bring influence to bear on the public and on the Government. Any individual is less powerful by himself than when he is associated with others seeking the same object. An active society is a corporation with a perpetual succession, and it never dies. The work carried on by an isolated student ceases at his death, but the work done by a number of students associated together goes on and on. As one man drops out, another takes his place.

An excellent example of the reciprocal influence of scientific workers and of a scientific institution upon each other is afforded by the Royal Institution. Without Davy, Faraday, or Tyndall, the Royal Institution would never have become the important body it now is. But without the Royal Institution neither Davy nor Faraday would have had any opportunity for carrying out their scientific work and of obtaining their scientific reputation, and perhaps the same may be said to a certain extent of Dr. Tyndall.

The history that I have been tracing comprises within it a record of the advance in many directions of our acquaintance with the secrets of nature, of our turning that acquaintance to practical account, and of the consequent progress of the nation in material prosperity. It bears witness likewise to that specialisation in science, which, though by no means an unmixed blessing, seems to be of necessity associated with all advancement in natural knowledge. The days are long since past when any single individual could attempt to cope with the whole encyclopædia of science, but the question not unfrequently arises at the present day whether the position of the specialist would not be more secure were the foundations on which he builds extended over a larger area, and were his scientific sympathies somewhat wider in their character.

Another question that may be asked is whether there is any need for this multiplicity of societies. The answer from any one who in whatever manner believes in evolution will be, that at the time of founding each society a necessity for it must at all events have been thought to exist, and that the analogous societies at that time in being must have been either unable or unwilling to adjust or expand themselves so as to include the subject for the study of which the new society was instituted. Many of the subjects, for instance, that originally came within the domain of the Royal Society, and indeed are still included within it, have by degrees been not absolutely banished from it, but relegated in the main to other societies, founded more especially for the study and illustration of such subjects. The Linnean, the Astronomical, the Chemical, and the Geological Societies afford instances in point, and any attempt to suppress such societies, and to bring their members all within the fold of the Royal Society, would have a disastrous effect on the advance of science, and would absolutely overweight the powers of the Royal Society itself. At the same time it must be remembered that accounts of important discoveries in any of these branches of knowledge are cordially welcomed by the Royal Society, and that it is usually the case that the leading Fellows of these special societies are also Fellows of the Royal Society. The same in a lesser degree holds good with the Society of Antiquaries, as archæological discoveries, especially when bearing on the early history of man, are welcomed alike on both sides of the quadrangle at Burlington House.

Turning to the more purely philosophical societies that have been established in London, it would seem as if for some reason or other the soil was not congenial for their growth or longevity. The Dialectical Society, founded in 1865, was dissolved in 1888; the Psychological, founded in 1875, ceased to exist in 1879, but was resuscitated under the name of the Society for Psychical Research in 1882. The Zetetical Society, established in 1878, and the Aristotelian in 1880, do not appear in Whitaker's List of Societies and Institutions, though the latter, notwithstanding that its members are few, is still in active operation. Altogether the number of those interested in abstract philosophy seems to bear no proportion to that of the votaries of the study of nature in all its phases and of those who devote themselves to the application of science to the good of mankind.

In the Institut de France, one of the Académies is that of Sciences Morales et Politiques, which, however, is divided into five sections. Of the eight places devoted to philosophy, only six were filled at the beginning of the present year, but this may have been purely accidental. The mention of the Institut suggests the question how far a similar association of academies would meet the requirements of this country. Such a question is beyond the limits of the present address, but in passing I may say that the necessary limitations of the Institut, the payment for attendance, the method of election of its members, and its close connection with the Government of the day, all present features which are hardly in accordance with our insular traditions. In Paris itself the Institut has had to be supplemented by various important scientific societies, such, for instance, as the Geological Society and the Society of Antiquaries of France.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. S. H. Hodgson has been appointed an elector to the White's professorship of moral philosophy in succession to the late Prof. Henry Sidgwick.

It will shortly be proposed in Convocation to confer the degree of D.Sc., *honoris causa*, upon Dr. Oliver J. Lodge, principal of the University of Birmingham.

Science scholarships are announced for competition on December 4 at Balliol College, Trinity College and Christchurch; on December 11 at Magdalen College; on January 15 at Jesus College.

CAMBRIDGE.—The complete degree of M.A., *honoris causa*, is to be conferred on Mr. G. H. F. Nuttall, M.D. California, Ph.D. Göttingen, University lecturer in bacteriology and preventive medicine, and on Mr. T. Strangeways Pigg, Advanced Student of St. John's College, University demonstrator of pathology.

The Special Board for Medicine propose a new scheme for the degrees of M.B. and B.C., whereby candidates shall be required to pass a suitable examination in pharmacology (*i.e.* the physiological actions of remedies), and in general pathology and the elements of hygiene, before admission to the final or qualifying examination in medicine, surgery and midwifery.

THE new Ravenscroft metallurgical laboratory of the Birkbeck Institution will be opened on Saturday next, December 1.

DR. BRILLOUIN has been nominated to succeed the late Prof. Bertrand as professor of general and mathematical physics at the Collège de France.

DR. THOMAS BUZZARD, a Fellow and member of the Council of King's College, London, has been appointed one of the representatives of the college upon the Senate of the University of London, in succession to Lord Lister, who has resigned.

AT a meeting of the associates of the Owens College, Manchester, held on November 21, Prof. J. J. Thomson, F.R.S., who is himself an associate, was elected a representative of the associates on the Court of Governors of the college for a period of five years.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, August 21.—"Note on the Occurrence of a Seed-like Fructification in certain Palæozoic Lycopods." By D. H. Scott, M.A., Ph.D., F.R.S.

The specimens described in the present note show that seed-like bodies, identical with those figured by Williamson under the name of *Cardiocarpon anomalum*, were borne on Lepidodendroid cones, otherwise indistinguishable from *Lepidostrobus*. They thus prove that under the genus *Cardiocarpon*, and even under the "species" *C. anomalum*, totally different objects have been confounded, namely, the seeds of Cordaiteæ or Cycads

on the one hand, and the integumented megasporangia of certain Palæozoic Lycopods on the other. The latter organs present close analogies with true seeds, but are wholly distinct in detailed structure from the Gymnospermous seeds above mentioned. The discovery of the specimens of the new cone is due to Messrs. J. Lomax and G. Wild, who recognised it as a *Cardiocarpon*-bearing strobilus, resembling a *Lepidostrobus*. The original specimens, which are calcified and generally well preserved, were derived from the Ganister beds of the Lower Coal-measures of Lancashire. A closely similar fructification occurs, at a much lower horizon, in the Burntisland beds of the Calciferous Sandstone Series.

The strobilus is of the ordinary *Lepidostrobus* type. The cylindrical axis bears numerous spirally disposed sporophylls, each of which consists of a long horizontal pedicel, expanding at the distal end into a rather thick lamina, which turns vertically upwards. Anatomically, the structure is also that of a *Lepidostrobus*. The ligule is sometimes well preserved; it is seated in a depression of the upper surface of the sporophyll, at the distal end of the sporangium, and is thus in the normal position.

With one exception, the specimens of the strobilus are immature, and their tissues not quite fully differentiated. These younger specimens bear sporangia which are essentially those of a *Lepidostrobus*. A single large sporangium is seated on the upper surface of the horizontal pedicel of each sporophyll, to the median line of which it is attached along almost its whole length. The sporangial wall has the structure characteristic of *Lepidostrobus*. Within the sporangial cavity, the membranes of the megaspores are usually preserved; a single large megaspore almost fills the sporangium, but smaller, abortive spores, with thicker walls, are also present. It appears that a single tetrad was developed in each megasporangium, and that of the four sister-cells one only came to perfection, constituting the functional megaspore.

In one specimen, discovered by Mr. Wild, the strobilus is in a more advanced condition. In its upper part the sporophylls simply bear sporangia, as above described, but lower down in the cone these are replaced by integumented, seed-like structures, identical with the detached bodies called *Cardiocarpon anomalum* by Williamson. Mr. Wild's specimen, then, demonstrates that the *Cardiocarpon anomalum* of Williamson was borne on a cone with all the characters of a *Lepidostrobus*, and that it represents the matured condition of the megasporangium and sporophyll.

The detailed comparison of specimens in the young and the mature condition has shown the nature of the change, which converts the megasporangium, together with its sporophyll, into a seed-like organ. A thick integument has grown up from the sporophyll, completely overarching the megasporangium, except for a narrow crevice left open at the top. When seen in a section tangential to the strobilus as a whole, this crevice is cut across, and presents exactly the appearance of a micropyle; in reality it differs from a micropyle in being a narrow slit, extending almost the whole length of the sporangium, in the radial direction, whereas the micropyle of an ordinary seed is a more or less tubular passage.

In a strobilus associated with the seed-like specimens, and probably of the same species, but bearing microsporangia, it was found that the latter, like the megasporangia of the female cone, are provided with integuments.

The Burntisland specimens, which from their horizon are presumably of a distinct species, are of interest for two reasons: in one specimen the ligule is clearly shown, enclosed by the integument, the only example of this organ so far observed in the mature, seed-like stage of the fructification. Another of the Burntisland specimens was the first observed in which the prothallus was present. It fills a great part of the functional megaspore, which is almost co-extensive with the sporangial cavity, and consists of a large-celled tissue, resembling the prothallus of *Isoetes* or *Selaginella*. The peripheral prothallial cells are smaller than the rest, but no archegonia could be detected. [In a section, since examined, cut by Mr. Lomax from one of the Coal-measure specimens, the prothallus is even better preserved. October 9, 1900.]

The bodies described in this note resemble true seeds in the possession of a testa or integument, and in the fact that one megaspore or embryo-sac alone came to perfection; the seed-like organ was likewise shed entire, and appears to have been indehiscent. In many points of detail, however, the reproductive bodies in question differ from the seeds of any known Gymnosperms; they afford no proof of the origin of the latter class from the Lycopods. The newly-discovered fructification nevertheless shows that certain Palæozoic Lycopods crossed the boundary line which we are accustomed to draw between Sporophyta and Spermophyta. As these fossils appear worthy of generic rank, it is proposed to found the genus *Lepidocarpon* for their reception.

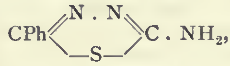
Physical Society, November 23.—Prof. Everett, F.R.S., Vice-President, in the chair.—A paper on a self-adjusting Wheatstone's Bridge, by E. H. Griffiths and W. C. D. Whetham, was read by Mr. Whetham. The object of this paper is to describe a cheap and easy method of getting a self-adjusting bridge to show on a scale the actual resistance of any wire. Contact with the bridge wire is made by means of a light horozontal bar, which is suspended by a phosphor-bronze strip from the coil of the d'Arsonval galvonometer used with the instrument. A second bar, parallel to and above the first, is rigidly connected with the coil. A wooden beam, worked by clockwork, moves up and down between the bars and clamps them alternately. When the beam is down contact is made with the bridge wire. If this contact is not at the zero point a current will flow through the coil, and if the cell is connected up the proper way, it will turn the coil so as to bring the upper bar nearer to the null point. This puts a twist into the phosphor-bronze strip, and when the beam rises and clamps the upper bar the torsion comes into play, and brings the lower bar under the upper one. The beam then descends and makes contact at this point, and if any current flows through the galvanometer there is further movement until the null point is reached. Any alteration in the resistance of the wire under experiment causes a movement of the zero point on the bridge wire, and this is followed by the lower arm. The position of the lower arm can be directly indicated by means of a scale. Prof. S. P. Thompson asked how the scale was calibrated. Mr. Whetham said the scale was arbitrary, but it could be calibrated by the known resistance of the bridge wire per unit length. Extension of the range can be obtained by shunting the bridge wire with various resistances. Mr. Glazebrook asked how sensitive the bridge was. Mr. Whetham said that working with a dry cell it could easily indicate one degree on a platinum thermometer. Mr. Blakesley pointed out that if the cell was connected up the wrong way the zero point would be an unstable one.—A paper on the liquefaction of hydrogen was read by Dr. M. W. Travers. These experiments were undertaken in order to provide liquid hydrogen in sufficient quantity for the separation of neon from the helium with which it is usually mixed. The separation is effected by cooling the gases to the temperature of hydrogen boiling at atmospheric pressure. The principles and conclusions do not differ from those of Dewar, but as the production of liquid hydrogen is neither difficult nor costly, an account of the experiments is given. In 1884 Wroblewski showed that strongly cooled and compressed hydrogen, on being allowed to expand, formed mist or spray in the tube; and later Olszewski repeated these experiments on a larger scale and determined the temperature of the liquid. Other methods of liquefying hydrogen have been suggested by Lord Rayleigh and Kammerlingh Onnes. In the case of many gases a fall of temperature takes place on free expansion, but under ordinary circumstances the temperature rises in the case of hydrogen and helium. The principle of free expansion was first applied by Hampson and Linde to the liquefaction of air. Within the last two years Dewar has shown that, at a temperature close to $-200°$ C., hydrogen behaves as an imperfect gas and becomes cooled when allowed to expand. This principle has been applied by Dewar to the liquefaction of hydrogen in quantity. In the author's experiments, hydrogen under a pressure of 200 atmospheres passes through a coil which is cooled to $-80°$ C. by a mixture of solid carbonic acid and alcohol. It then enters another coil contained in a chamber which is continually replenished with liquid air. The lower portion of this coil passes into another chamber, which is closed and communicates through a pipe with an exhaust pump. Liquid air flows continuously from the first chamber into the second through a pin valve controlled by a lever. The liquid air, boiling under a pressure of 100 mm. of mercury, lowers the temperature to $-200°$ C. The gas then passes into a regenerator coil, which is enclosed in a vacuum vessel, and expanding at a valve, passes upwards, through the interstices of the coil and the annular space surrounding the chambers through

which the gas first passes, to an outlet whence it can return to the main supply pipe. The liquid which separates from the gas is ultimately collected in a vacuum vessel. The apparatus, with the exception of the compressor, motor and Hampson air liquefier, is comparatively inexpensive. About 50*l.* is required for the additional apparatus, and each time liquid hydrogen is made involves a further expenditure of about a sovereign. Dr. Hampson said he would like to offer a correction. Dr. Travers had said that he (Dr. Hampson) was the first to liquefy air by the application of the counter current process to the Joule-Thomson effect. Although he was the first to make the proposal he was not the first to apply it. He made the proposal to Prof. Dewar's assistant in 1894, and air was liquefied by Prof. Dewar by this method. Dr. Travers had referred at length to a valve which he (Dr. Hampson) had devised, but as it was straightforward common sense he did not wish to accept any credit for the use it had been to the author in his experiments. He would like to call attention to the remarkable features of the work in two respects—the economy of means and the magnitude of results. By means of liquid hydrogen Prof. Ramsay and Dr. Travers had succeeded in obtaining the physical and other properties of some of the rarer gases. Prof. S. P. Thompson said the author had asserted that the Joule-Thomson effect for hydrogen changes in sign at some temperature, and expressed his interest in the fact that it was possible to get a cooling effect by allowing hydrogen to expand. Mr. Boys asked if it was necessary or desirable to allow the hydrogen to expand to atmospheric pressure. Dr. Travers said the mechanical advantages of this were great. Dr. Lehfeldt asked if there had been any attempt to determine the temperature of the liquid, and, secondly, if the apparatus could be employed to determine the magnitude of the Joule-Thomson effect. Dr. Harker asked if the temperature at which the Joule-Thomson effect changes sign was known. Dr. Donnan said that the effect changed sign at the temperature at which "PV" was a minimum. Dr. Travers, in reply to Dr. Lehfeldt, said he had not determined the temperature of the liquid, and the apparatus was not suitable for measuring the Joule-Thomson effect. He should say that the change of sign occurred about $-150°$ C. It was Daniel Berthelot who first pointed out that the change of sign corresponded with the minimum value of "PV," but the experiments of Amagat on the relation between pressure and volume were not sufficiently accurate to fix the temperature.—A paper on the anomalous dispersion of carbon, by Prof. R. W. Wood, was taken as read. Experiments were made with smoke films and with films deposited on plate glass in a vacuum by an incandescent lamp. The dispersion was first measured with a Michelson interferometer, illuminated with monochromatic light of various colours, obtained by prismatic analysis. The fringes were photographed and measured, readings being obtained between wave-lengths ·000040 cm. and ·000066 cm. The results show a steady increase of refractive index from blue to red. The refractive index for sodium light was measured by estimating the thickness of the film and the fringe displacement, and was found to be 2·2. A prismatic deposit of smoke was then made by allowing a piece of plate glass to move uniformly backwards and forwards over the top of a small flame. The deviation produced by this prism was measured by means of a direct vision spectroscope with the prisms removed. Experiments were performed with red and blue light. The mean deviation of red and blue was taken for sodium light, and this result was in good agreement with the deviation obtained by the interferometer method.—A paper on the refraction of sound by wind, by Dr. E. H. Barton, was taken as read. Assuming that the wind is everywhere horizontal, and does not vary in any one horizontal plane, but is different at different levels, then the following results are obtained for rays in the same vertical plane as the wind: (1) The direction of propagation is not usually at right angles to the wave front where there is a wind, consequently the cosecant law for the wave front needs supplementing by another expression giving the direction of the ray. (2) Total reflection cannot occur if the wave front is initially horizontal. (3) In a region where the horizontal wind increases uniformly as we ascend, the rays, instead of forming a catenary, describe a more complicated curve, which, however, reduces to a parabola in the special case of rays whose wave fronts are horizontal. In the paper the relation between direction of propagation and wave front is first worked out and then the refraction of waves and rays on crossing into a new wind zone is considered. This principle is then applied to the diffraction through any number of parallel wind zones, and it is shown that the final inclinations of wave fronts and rays are independent of the characteristic constants of the intermediate zones. It is shown that since a cosecant cannot have a value between $+1$ and -1, total reflexion becomes possible. If, however, the wave front is initially horizontal there is no refraction of the wave front and no total reflexion, but the ray deviates without limit from the vertical, and tends to correspond with the wave front. When reflexion occurs it follows the ordinary optical law. The society then adjourned until December 14, when the meeting will be held at the Royal College of Science, South Kensington.

Chemical Society, November 15.—Prof. Thorpe, President, in the chair.—The following papers were read:—Trichlorobenzoic acid, by F. E. Matthews. Benzonitrile hexachloride is acted upon by alcoholic soda with production of a mixture of trichlorobenzoic acids from which a new trichlorobenzoic acid was isolated; the new acid gives an ester with hydrogen chloride and alcohol and is, therefore, the 1 : 2 : 4-trichloro-3-benzoic acid.—Oxidation of benzalthiosemicarbazone, by G. Young and W. Eyre. Benzalthiosemicarbazone,

$$CHPh : N . N : C(SH) . NH_2,$$

is oxidised to amidophenylthiodiazole,



by ferric chloride. Similar oxidation products are obtained from the 4-substituted methyl and phenyl benzalthiosemicarbazones.—The nitration of benzeneazosalicylic acid, by J. T. Hewitt and J. J. Fox. With dilute nitric acid, benzeneazosalicylic acid yields benzeneazoorthonitrosalicylic acid, whilst with strong nitric acid, paranitrobenzeneazosalicylic acid is obtained.—Upon the collection and examination of the gases produced by bacteria from certain media, by W. C. C. Pakes and W. H. Jollyman. The strictly ærobic organism *Bacillus pyocyaneus* grows in media containing 1 per cent. of potassium or ammonium nitrate under anærobic conditions; the authors conclude that the terms ærobic and anærobic must be extended so as to include the presence of oxygen in the form of nitrates. The gases produced by this organism from nitrated media contain nitrogen and small quantities of oxygen.—The bases contained in Scottish shale oil, by F. C. Garrett and J. A. Smythe. The basic mixture separated from Broxburn shale oil seems to contain no pyridine; α-picoline, $\alpha\gamma\alpha'$-trimethylpyridine, and $\alpha\beta$- and $\alpha\beta'$-dimethylpyridine were isolated from it.—On a simplified method for the spectrographic analysis of minerals, by W. N. Hartley and H. Ramage.

PARIS.

Academy of Sciences, November 19.—M. Maurice Lévy in the chair.—Note on the telescopic planets, by M. de Freycinet. The asteroids studied, 428 in number, appear to belong to eight independent rings, each of which, before breaking up into fragments, turned as one piece round the sun. This hypothesis as to their formation requires three conditions, all of which are shown to be fulfilled.—On the aërostatic observation of the Leonids, by M. J. Janssen. The observations from the balloons ascending from Paris were obscured by clouds, although an altitude of over 13,000 feet was attained. Observations at other stations were also spoiled by the state of the weather.—Sir Joseph Hooker was elected a Foreign Associate in the place of the late Prof. R. Bunsen.—Observations of the Leonid swarm at Meudon, by M. H. Deslandres. Only nine Leonids were seen on the two nights.—On some applications of non-euclidian geometry, by M. Servant.—On the summation of series, by M. Émile Borel.—On a new shadow analyser, by M. J. Macé de Lépinay. The new analyser may be used for any simple rays, and preserves its sensibility in convergent light. By applying a modification of Mouton's method, it is possible to measure easily thicknesses up to several centimetres with an accuracy of $0·14\ \mu$.—On the electrocapillary properties of mixtures and electrocapillary viscosity, by M. Gouy.—The direct combination of nitrogen with the metals of the rare earths, by M. Camille Matignon. A mixture of the oxide of the rare earth with aluminium and magnesium is heated in a tube containing air and connected with a manometer. Under these conditions, with lanthanum, praseodidymium, neodidymium and samarium, the absorption of the oxygen and nitrogen is very rapid; with cerium

and thorium the absorption, although complete, is slower.—Relation between the chemical constitution of the colouring materials derived from triphenylmethane and their absorption spectra in aqueous solution, by M. P. Lemoult. All the dyes examined gave in aqueous solution an absorption spectrum possessing a red luminous band, the centre of which was fixed in position ($\lambda = 6860$).—On blue chlorophylline, by M. M. Tsvett. By a particular mode of treatment, which is described in detail, the author has succeeded in obtaining crystals of a chlorophylline of a pure blue colour, apparently different from the phyllocyanine of Frémy and the chlorophyllines of Sorby and Gautier.—Cryoscopy of human sweat, by M. P. Ardin-Delteil. Normal sweat from a healthy man has an average freezing point of $-0°\cdot24$ C. It may vary in individual cases between $-0°\cdot08$ and $0°\cdot46$ C., the oscillations being in great part due to the variations in the quantity of common salt contained in the perspiration.—On the development of *Sclerostomum equinum*, by M. A. Conté.—On the exosmosis of diastases by plantules, by M. Jules Laurent. Seeds during germination may give out a portion of the diastases necessary to the digestion of their food reserves, and thus utilise certain insoluble organic materials, such as starch, but the phenomenon stops when germination ceases.—Origin of an ochreous clay, characteristic of the red diluvium, by M. Stanislas Meunier.—The uses of transparencies for combining the effects of the synodic revolution with those of terrestrial rotation, by M. A. Poincaré.—Observations on the Leonids at Algiers, by M. H. Tarry.

CAPE TOWN.

South African Philosophical Society, October 3.—T. Stewart, Vice-President, in the chair.—The Secretary communicated a paper by Dr. R. Broom, on *Ictidosuchus primaevus*, *nov. spec.* The paper contained a description of the remains of a small Theriodont reptile from the Karroo Beds of Pearston. The form is specially interesting as illustrating a new Theriodont type, and one which has many affinities with the Dicynodonts.—Prof. J. T. Morrison read a paper on some periodical changes in the rainfall at the Royal Observatory, Cape of Good Hope, since 1841. Prof. Morrison dealt with the records of rainfall that have been kept at the Royal Observatory since the year 1841. These showed certain regularities attended by many apparent irregularities. The author subjected the records to the process of mathematical analysis discovered by Fourier, and so showed evidences of two sets of fluctuations running simultaneously through the monthly amounts of rainfall. These fluctuations completed themselves in approximately nine and ten years respectively. The question of the reality of these fluctuations was considered, and tested by comparing their effects in producing apparent fluctuations of slightly different times, such as the well-known sun-spot period of about eleven years. The agreement was such as to make it probable that the two first-mentioned fluctuations are the two prevailing periodicities. The approximate values of some of their part-periods had been computed, and the totals gave a fair approximation to all the more striking changes that have occurred in the rainfall at the Observatory from year to year for the last sixty years. The author concluded that the coincidences were sufficient to warrant a careful investigation of the exact times of the chief fluctuations, and a computation of the magnitude of their sub-periods. He intends to prosecute the research.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 29.

GOLDSMITHS' INSTITUTE CHEMICAL SOCIETY, at 8.30.—The Profession of an Industrial Chemist: Dr. J. Lewkowitsch.

MONDAY, DECEMBER 3.

VICTORIA INSTITUTE, at 4.30.—The Proceedings of the Congress for the History of Religion, Paris: Theophilus G. Pinches.

TUESDAY, DECEMBER 4.

SOCIETY OF ARTS, at 8.—Electric Oscillations and Electric Waves: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be discussed*: Machinery for the Manufacture of Smokeless Powder: Oscar Guttmann.——*Papers to be read, time permitting*: The Signalling on the Waterloo and City Railway; and Note on the Signalling of Outlying Siding Connections: A. W. Szlumper.—Signalling on the Liverpool Overhead Railway: S. B. Cottrell.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Lantern Slides, Pastoral and Sundry: Colonel J. Gale.

ZOOLOGICAL SOCIETY, at 8.30.—On the Breeding Habits of *Protopterus Symnarchus*, and some other West African Fishes: J. S. Budgett.—On the Mammals collected during the "Skeat Expedition" to the Malay Peninsula 1899–1900: J. Lewis Bonhote.—On the Habits and Natural Surroundings of Insects and other Animals observed during the "Skeat Expedition" to the Malay Peninsula, 1899–1900: Nelson Annandale.

WEDNESDAY, DECEMBER 5.

SOCIETY OF ARTS, at 8.—Road Traction: Prof. H. S. Hele-Shaw, F.R.S.

GEOLOGICAL SOCIETY, at 8.—Bajocian and Contiguous Deposits in the Northern Cotteswolds: the Main Hill-Mass: S. S. Buckman.—On the Corallian Rocks of St. Ives (Hunts.) and Elsworth: C. B. Wedd.—The Unconformity of the Upper Coal Measures to the Middle Coal Measures of the Shropshire Coalfield, and its Bearing upon the Extension of the Latter under the Triassic Rocks: W. J. Clarke.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Examination of Extract o Malt: Dr W. J. Sykes and C. A. Mitchell.—(1) Note on the Estimation of Glycerine; (2) The Examination of Gum Resins: Dr. J. Lewkowitsch.—Note on the Occurrence of Barium in the Spring Water of Boston Spa: Percy A. E. Richards.—On the Analysis of Samarskite: Arthur G. Levy.

ENTOMOLOGICAL SOCIETY, at 8

THURSDAY, DECEMBER 6.

ROYAL SOCIETY, at 4.30.—*Probable* papers: The Histology of the Cell Wall, with Special Reference to the Mode of Connection of Cells. Part I. The Distribution and Character of "Connecting Threads" in the Tissues of *Pinus sylvestris* and other Allied Species: W. Gardiner, F.R.S., and A. W. Hill.—On the "Blaze Currents" of the Frog's Eyeball; Dr. A. D. Waller, F.R.S.—On a Bacterial Disease of the Turnip (*Brassica napus*): Prof. M. G. Potter.—The Micro-organism of Distemper in the Dog, and the Production of a Distemper Vaccine: Dr. S. M. Copeman.—On the Tempering of Iron Hardened by Overstrain: J. Muir.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—Santalenic Acid: A. C. Chapman.—Ammonium Bromide and the Atomic Weight of Nitrogen: A. Scott, F.R.S.—Interaction between Urethanes and Primary Benzenoid Amines: Dr. A. E. Dixon.—The Decomposition of Chlorates. Part III. Calcium Chlorate and Silver Chlorate: W. H. Sodeau.—Nitride of Iron: Gilbert J. Fowler.—The Heat of Formation and Constitution of Iron Nitride: Gilbert J. Fowler and Philip J. Hartog.—Relationships of Oxalacetic Acid: H. J. H. Fenton, F.R.S., and H. O. Jones.

RÖNTGEN SOCIETY, at 8.—Exhibition and Description of a Stereoscopic Fluoroscope and a New Rotary Mercury Break: J. Mackenzie Davidson.

LINNEAN SOCIETY, at 8.—On some New Foraminifera from Funafuti: C. Chapman.—On British Thrifts: G. Claridge Druce.

FRIDAY, DECEMBER 7.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Dock Gates: F. K. Peach.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of th English Coast. II. Dorsetshire: Dr. A. W. Rowe.

CONTENTS.

THURSDAY, DECEMBER 6, 1900.

THE RECENT SPORTING EXPERIENCES OF MR. SELOUS.

Sport and Travel, East and West. By F. C. Selous. Pp. ix. + 311; illustrated. (London: Longmans, Green, and Co., 1900.)

HAVING seen, or shot, practically every species of great game in South and South-east Africa, the indefatigable author of the volume before us has devoted several seasons in the closing decade of the century to hunting-trips in the northern hemisphere. These expeditions included three trips to Asia Minor in search of the wild goat, the Armenian sheep, and the Asiatic red deer, and two to the Rocky Mountains, where wapiti, mule-deer, white-tailed deer, prongbuck and lynx fell to the practised aim of the veteran hunter. Not that Mr. Selous is by any means merely a hunter; he is likewise an observant field-naturalist and an enthusiastic egg-collector, having contributed many years ago an important paper on African antelopes to the *Proceedings* of the Zoological Society, while his recent expeditions to Asia Minor have furnished material for an ornithological paper to the *Ibis*. It is perhaps needless to add that such an experienced hunter may be depended upon not to shoot animals for the mere sake of slaying, and that after obtaining a few fine examples of the species he encountered for the first time to add to his splendid collection at Alpine Lodge, Worplesdon, and occasionally killing an individual or two for the commissariat, Mr. Selous has always been content to stay his hand.

To compare in point of interest his recent experiences with those detailed in his "Hunter's Wanderings in Africa" would perhaps be unjust, if only for the reason that the number of species of game animals to be encountered in the lands he has lately visited falls immeasurably short of those which have their home on the South African veldt. Then, too, we have no such mighty beasts as the white rhinoceros and the African elephant to enthral the reader's interest in the volume. And it must also be remembered that hunting in the "Rockies' has been made familiar to us by the writings of sportsmen like Roosevelt, whereas at the date Mr. Selous gave to the world his unrivalled South African experiences, there had been comparatively little written on the subject of the large game of the interior since the trips of Gordon Cumming, Andersson and Oswell.

Nevertheless, in spite of having the prestige of his earlier *magnum opus* to contend against, it cannot be gainsaid that on the present occasion Mr. Selous has succeeded in producing a volume calculated to attract a large circle of readers, and these, too, not only from among sportsmen and travellers, but from naturalists as well. To the latter, at any rate, the greatest interest of the book is concentrated on the part devoted to shooting in Asia Minor, in which district we have a less full knowledge of the animals than is the case with those of North America. One of the points where the author has been of undoubted service to naturalists is in regard to his description of the seasonal colour-changes of the wild goat; such seasonal changes in the colour of horned game animals having till late years attracted comparatively little attention among zoologists. According to the description given by Mr. Selous, it appears that in the summer coat these goats are of a reddish-brown colour, with the broad dark shoulder-stripe, which becomes so conspicuous in winter, almost entirely wanting, the black beard being at the same time comparatively short. In winter, on the other hand, the old bucks have the general ground-colour nearly white, although the flanks and under-parts are somewhat darker, being of a light sandy-yellow. In marked contrast to these pale tints stands out the broad black shoulder-stripe and dorsal streak, while the beard becomes long and flowing.

It is interesting to note that, in spite of his full acquaintance with all the splendid South African representatives of the antelope tribe, Mr. Selous pronounces the wild goat of the Maimun Dagh to be one of the handsomest and most striking of all game animals, although he is careful to avoid making invidious comparisons. In its native mountains the wild goat is, indeed, one of the most wary of horned animals, and as it is by no means plentiful, its pursuit demands all the patience and resources of the skilled stalker. And the sympathies of all sportsmen will be with Mr. Selous when they read his account how, after many failures and losing one good head, he eventually killed a magnificent old buck, only to discover that it was minus one of its splendid horns. The statement, on p. 27, that the wild goats of the Musa Dagh (on which there is but a single spring of fresh water) frequently descend to the beach and drink sea-water, is certainly very remarkable, for although it is now well known that many species of ruminants can exist for long periods, if not altogether, without drinking, yet this is the first instance that has come under our notice of their resorting to the ocean for water. Although, in the absence of an index, it is a little difficult to be certain that we have not overlooked a passage, the author does not seem to have been successful in "bagging" the Armenian wild sheep, although he obtained several fine examples of the ollin, or Asiatic race of the red deer.

To visit the mountains and prairies of the north-western states of America appears to have been a life-long dream of Mr. Selous—a dream that was never realised till long after the bison had disappeared from the latter, and the numbers of the wapiti had been deplorably reduced in the former. In regard to the skulls of the bison which the author met with so commonly in the Bighorn basin, we are told that many of these still retained the sheaths of the horns and even fragments of skin and hair after an exposure of at least fourteen years. "I should certainly never have believed," he writes, "that even the hardest of bone, let alone horn and skin, could have withstood the ravages of time and exposure so well. In the climate of Africa no organic matter lasts very long when exposed to the weather, and even the skull and leg-bones of an elephant would, I think, crumble to dust and absolutely disappear in less than fifteen years from the date of the animal's death." At the present time, these observations are of considerable interest in connection with the skin of the ground-sloth preserved in a Patagonian cave.

Evidence of the former abundance of the wapiti and

the mule-deer in the same district was afforded by the number of bleached antlers which marked the line of the great spring migration, when the wapiti were returning to the mountains from their winter feeding-grounds on the plains. At the present day, these noble deer are unknown on the low-grounds of the Bighorn basin, and the few survivors have to make shift as best they can during the dreary winter months in the mountains, from among the pine forests of which they emerge as seldom as possible.

Mr. Selous was fortunate enough to obtain some very fine heads of wapiti, white-tailed deer and mule-deer, one head of the latter being a remarkably good specimen, and notable on account of the relatively narrow span of the antlers. To one expression which the author is very fond of using—to wit, a "bull" wapiti—we are fain to take exception, the term "stag" being the proper one to employ in this connection. And here we may venture to point out to the author, in connection with a statement on page 166, that naturalists of the present day (whatever may have been the practice with their predecessors) are not in the habit of translating generic terms into English, and that, consequently, there is no objection to the application of the name Antilocapra to the American prongbuck, on the ground that it indicates an animal midway between an antelope and a goat. Such names should be regarded as mere abstract terms without any definite meaning. And, while we are fault-finding, it may be mentioned that there are a few little slips in nomenclature which might advantageously have been avoided. The rough-legged buzzard, for instance, is not an Aquila (p. 140), while Speotyto, and not Speotitis (p. 145), is the proper title for the little American ground-owls. It may be added that it would have been a decided improvement to the book if, instead of making the title the heading of every page, the chapter-headings had been employed for the right-hand pages.

A reviewer is always expected to pick some holes in a book, but it may be candidly stated that the foregoing are all the faults we have to find with the one before us. To those who contemplate a trip to either of the districts visited by Mr. Selous, as well as to those stay-at-home people who prefer to hear of stirring adventures by field and flood when comfortably seated by their own firesides, rather than undergo the inseparable hardships and toils themselves, we can confidently recommend "Sport and Travel" as an attractive and interesting volume, written by one who is at the same time a keen sportsman and an intelligent and thoughtful observer. R. L.

THE COMPARATIVE HISTOLOGY OF VERTEBRATES.

Lehrbuch der vergleichenden mikroskopischen Anatomie der Wirbeltiere. Herausgegeben von Dr. Med. Albert Oppel—Dritter Teil. Pp. x. + 1180. (Jena: Gustav Fischer, 1900.)

PROF. OPPEL has set himself the colossal task of furnishing a succinct account of the comparative histology of vertebrates, and the volume before us is the third instalment towards the attainment of that end. The two former parts, which appeared in 1896 and 1897, dealt respectively with the comparative structure of the stomach and of the gullet and intestines. The present is concerned with the remainder of the alimentary canal, viz., the mouth, including the tongue and salivary glands (but exclusive of the teeth, which are referred to a later publication in which the skeleton will be dealt with) and the large glands whose ducts open into the commencement of the intestine, viz., the pancreas and liver. The extent of the undertaking will be manifest when we mention that the account of these subjects requires nearly 1200 large octavo pages, with 679 illustrations in the text and ten coloured lithographic plates, and that there is a bibliographical list comprising several hundred books and papers, each one of which is referred to in the text, and all of which are given with their full title and references; so that the possession of this alone would render the book of inestimable value to any one working at any part of the subject with which it deals.

As we have pointed out in noticing the parts of Prof. Oppel's work which have already appeared, the author has not attempted to verify all the statements and descriptions which he gives; such verification would indeed be an impossible task when we consider the enormous amount of material which has accumulated upon the subject, even within recent years. Nevertheless, there are several points in the present volume upon which Prof. Oppel has made personal observations, and although these are not published in this book for the first time, their appearance tends to give an air of originality to a work which, in the main, must necessarily be a compilation, however critically the matter which it contains is dealt with; but it will be easily understood that where, as in a work of this character, conciseness must be a main object there cannot be much room for criticism.

A feature of the work is the chronographical order in which the results of investigation upon each subject dealt with are put before the reader, an arrangement which gives a special interest of a historical character to many of the descriptions. This is well exemplified in the chapters dealing with the relation between the structure of glands and their condition of activity, in which, as in many other parts of the book, the author contrives to introduce points of high physiological interest into a work the chief aim of which is no doubt morphological. Where all is excellent it is not easy to particularise; but certain parts are especially dealt with in a masterly manner, as, for example, the structure and relations of the tonsils and similar lymphatic tissues in the mouth and pharynx, the papillæ of the tongue and the distribution of taste buds upon them, the structure of the lingual and salivary glands and pancreas in mammals, including the changes which they undergo during secretion, their secretory capillaries, their nerves and nerve-endings. The account of the pancreas embraces, not only a minute description of the glandular substance proper and of the changes which its cells undergo in different physiological conditions, but also a careful description of the intertubular islands which were first described by Langerhans, and which have recently attracted attention on account of the possibility, which has been expressed by more than one writer, that the influence which that gland exerts upon the carbohydrate metabolism of the body (its entire removal is always followed by severe diabetes) may be dependent upon an internal secretion produced by the cells in question.

The part which is devoted to the liver opens with a comparison of the structure of that with other glands, and is followed by a historical account of the discovery of the bile canaliculi, which furnishes an excellent example of the value of applying the methods of physiology to the elucidation of structure. The treatment of the liver cell alone occupies some forty pages, although this is a subject which, in most text-books of histology, is considered to be sufficiently dealt with in as many lines. Another important part of this section, not merely from a morphological but also from a pathological point of view, is that devoted to the connective tissue of the lobules, which was originally shown by von Fleischl (working with Ludwig) to be so abundant; a fact which has been confirmed and extended by several observers employing modern histological methods. Like its predecessors, this volume is a storehouse of information upon the subjects of which it treats, and must remain for many years an indispensable work of reference, not only to the comparative anatomist and histologist, but also to the physiologist. E. A. S.

OUR BOOK SHELF.

Flies Injurious to Stock. By Eleanor A. Ormerod, LL.D. Pp. 80. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1900.)

MISS ELEANOR A. ORMEROD continues her useful work of popularising the information which has been acquired concerning the life-histories of injurious insects by issuing, in a form accessible to all, an account of the principal dipterous pests which infest stock.

The book does not pretend to be a contribution to science, for Miss Ormerod's own important observations on the "Warble-fly" have been several times previously published, and the rest of the work is mainly compiled from various authors whose papers are duly referred to in footnotes.

The Hippoboscidæ are represented by the "forest-fly" and the so-called "sheep-tick," but most of the book is devoted to an account of the Tabanidæ or "gad-flies" and the Œstridæ or "bot-flies," and the writer tries to make clear the differences in structure and habits between the members of these two families. Much general ignorance exists with regard to the common biting flies, and the brief account of them here given will, we imagine, be particularly welcome. Considering the frequency of their occurrence, remarkably little is known of the early history of some of these insects, but Miss Ormerod is surely in error in stating that that of *Haematopota* is unknown, for the larva has been described and figured by Perris.

The Œstridæ, economically the most important family, naturally come in for the fullest treatment. Errors which have crept into the usual accounts of the "sheep's nostril fly" are corrected. Larvæ, not eggs, are laid in the sheep's nostril, but though they work up into the nasal passages, they never, as is often stated, reach the brain.

A second horse bot-fly which occurs in this country, *Gastrophilus haemorhoidalis*, might have been mentioned, especially as it is more easy of detection and more susceptible of treatment than the common species.

The otherwise excellent account of the "warble-fly" is marred by the incorporation of a large amount of correspondence, the gist of which might have been compressed into a few lines. However appropriate the inclusion of these letters in Miss Ormerod's original papers on the subject, they seem out of place in a *résumé* such as that before us.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Value of Magnetic Observatories.

IN answer to those who consider that the magnetic results obtained at Kew Observatory are of little or no practical value, I would offer the following remarks for their consideration. The railway engine driver may run his 70 miles an hour on rails, certain as to being on the right road, and in like manner the electric tram car driver may keep in the right direction.

The sailor, however, on the trackless ocean, has only his compass to guide him, at best directed by that unstable magnet the earth. But the earth by induction transforms his iron or steel ship into a still less stable magnet, which not only disturbs the compass on board but permanently reduces the value of the earth's directive force on that compass by ·1 or ·2 of that observed on land.

Fortunately, as the knowledge of terrestrial magnetism increased, men of science were gradually enabled to solve the at one time knotty problem of a ship's magnetism, and the seaman can now run his vessel over twenty knots an hour in safety on a dark night. Without a knowledge of terrestrial magnetism, the now universal iron or steel ship would have been almost an impossibility, and the faster ships go the more necessary does that knowledge become, to wit in the navigation of the St. Lawrence and English Channel. The sailor is continually asking for charts of the magnetic declination to be brought up to date; Kew and other magnetic observatories help largely in this direction.

Moreover, a theory of terrestrial magnetism is much wanted which (letting alone other possibilities) would enable us to provide accurate charts of the magnetic elements years in advance, in the same manner that the "Nautical Almanac" is prepared. Hence the importance of Kew as a valuable link in the chain of magnetic observatories, which has already been reduced by the destruction caused by electric tramways.

Blackheath, S.E. ETTRICK W. CREAK.

Huxley's Ancestry.

WITH reference to Lord Avebury's reminiscences of Huxley, and the summary of his views concerning British races, it may be of interest to quote Huxley's account of his own racial characters, as contained in a private letter written ten years ago: "My father was a Warwickshire man; my mother came of Wiltshire people. Except for being somewhat taller than the average of the type, she was a typical example of the 'Iberian' variety—dark, thin, rapid in all her ways, and with the most piercing black eyes I have ever seen in anybody's head. Mentally and physically (except in the matter of the beautiful eyes) I am a piece of my mother, and except for my stature, which used to be 5 feet 10, I should do very well for a "black Celt" —supposed to be the worst variety of that type. My father was fresh-coloured and grey-eyed, though dark-haired, good-humoured, though of a quick temper, a kindly man, rather too easy-going for this wicked world. There is a vein of him in me, but the constituents have never mixed properly. . . . I know of Huxleys in Staffordshire, Worcestershire and Wales, and I incline to think that the Huxleys of Huxley [Cheshire] are responsible for most of us, and that, upon the whole, we are mainly Iberian mongrels, with a good dash of Norman and a little Saxon." This was written for my private information, as bearing on certain inquiries into "genius" and race, but there can be no objection to its publication now.

HAVELOCK ELLIS.

Quartz-Calcite Symmetrical Doublet.

AT the Bradford meeting of the British Association, Section A, I offered to lend this lens for purposes of research to any investigator who would satisfy me as to his qualification for taking the necessary care of it. I am now ready to do so.

Oaklands, Chard, November 26. J. W. GIFFORD.

ON SOLAR CHANGES OF TEMPERATURE AND VARIATIONS IN RAINFALL IN THE REGION SURROUNDING THE INDIAN OCEAN.[1]

II.

Indian Rainfall. S.W. Monsoon, 1877–1886.

IT will be clear from what has been stated that our object in studying rainfall was to endeavour to ascertain if the + and − temperature pulses in the sun were echoed by + and − pulses of rainfall. The Indian rainfall was taken first, not only because in the tropics we may expect the phenomena to be the simplest, but because the regularity of the Indian rains had broken down precisely when the widened line observations showed a most remarkable departure from the normal.

It was also important for us to deal with the individual observations as far as possible, because it was of the essence of the inquiry to trace the individual pulses if they were found. Hence the S.W. monsoon was, in the first instance, considered by itself, because although Eliot holds that the winter rains (N.E. monsoon) are due to moisture brought by an upper S W. current,[2] their incidence is very different and their inclusion might mask the events it was most important to study.

The first investigation undertaken was the study of the rainfall tables published by the Meteorological Department of the Government of India. These were brought together by Blandford down to the year 1886.[3] As the widened line observations were not begun at Kensington till 1879, the discussion was limited in the first instance to the period 1877–1886 inclusive, embracing the following changes in solar temperature, occurring, as will be seen, between two conditions of mean solar temperature :—

Mean	− pulse	Mean	+ pulse	Mean
1876	1877–1880	1881	1882–1886	1886–1887

Bearing in mind that the intensity of the + pulse may in some measure be determined by the solar disturbances, which for the present are registered by spotted area, it is important to point out that the preceding maximum in 1870 was remarkable for obvious indications of great solar activity.[4]

It soon became evident that in many parts of India the + and − conditions of solar temperature were accompanied by + and − pulses producing pressure changes and heavy rains in the Indian Ocean and the surrounding land. These occurred generally in the first year following the mean condition, that is, in 1877–8 and 1882–3, dates approximating to, but followed by, the minimum and maximum periods of sun-spots.

Meldrum, as far back as 1881,[5] referred to "the extreme oscillations of weather changes in different places, at the turning-points of the curves representing the increase and decrease of solar activity."

It was especially in regions such as Malabar and the Konkan when the monsoon strikes the west coast of India, that the sharpness and individuality of these pulses was the most obvious.

One method of study employed has depended upon Chambers's view (*Indian Meteorological Memoirs*, vol. iv. Part 5, p. 271) that the S.W. monsoon depends upon the oscillations of the equatorial belt of low pressure up to 31° N. lat. at the summer solstice. The months of rain-receipt on the upward and downward swing will therefore depend on the latitude, and these months alone have been considered.

We began by taking elevated stations in high and low latitudes.

Leh Lat. 34° N. 11,500 feet	The 1881 pulse (in July) was the heaviest recorded (1·77 inches) save one in 1882 ; the rainfall was nearly as high. The pulse felt in 1878 was the highest of all.
Murree Lat. 33° N. 6344 feet	The 1881 pulse (Aug.) is high, but is followed by a higher next year. The 1878 pulse (Aug.) is highest of all.
Newera Eliya Lat. 7° N. 6150 feet	Taking the fall in July and Aug. The 1881 pulse occurs in 1882, and is highest. Next comes the pulse in 1878.

It must also be stated that if we take the sun-spot maximum, including the period we have chiefly discussed (1877–1886), as normal, it is found that there are variations in rainfall accompanying the preceding and succeeding maxima of 1870 and 1893. This variation indicates the existence of a higher law, but there has not been time to discuss them thoroughly enough to justify any definite statements about them.

The Rainfall of "Whole India."

The next step was to work on a longer base, and for this purpose Eliot's whole India table of rainfall, 1875–1896 (NATURE, vol. lvi. p. 110), embracing both the S.W. and N.E. monsoons, being at our disposal, was studied.

It was anticipated that such a table, built up of means observed over such a large area and during both monsoons, would more or less conceal the meaning of the separate pulses observed in separate localities ; this we found to be the case. But, nevertheless, the table helped us greatly, because it included the summation of results 9 years later than those included in Blandford's masterly memoir. Predominant pulses were found in 1889 and 1893, following those of 1877–8 and 1882–3. So that it enabled us to follow the working of the same law through another sun-spot cycle, the law, that is, of the mean solar temperature being followed by a pulse of rainfall.

Mean sun	Rain pulse
1876	− 1878
1881	+ 1882
1886–7	− 1889
1892	+ 1893

The main feature of this table is the proof of a tremendous excess of rainfall in 1893—by far the greatest excess of all (percentage variation, +22). This was far greater than the excess in 1882.

The next remarkable excess occurs in 1878 (percentage variation, + 15).

The pulses in the period stand as follows :—

	Percentage variation	Heat pulse	Remark
Min. 1878	+15	−	Years after rise of iron lines.
Max. 1882	+ 6	+	Years after rise of unknown lines.
Min. 1889	+ 6	−	Years after rise of iron lines.
Max. 1893	+22	+	Years after rise of unknown lines.

[1] By Sir Norman Lockyer, K.C.B., F.R.S., and W. J. S. Lockyer, M.A. (Camb.), Ph.D. (Gött.) Paper read before the Royal Society on November 22. Continued from p. 109.

[2] Report, 1877, p. 125.

[3] "Indian Meteorological Memoirs," vol. iii.

[4] "The year 1870 was characterised by an exuberance of solar energy, which is without parallel since the beginning of systematic observations (*i.e.* since 1825). The number of observed groups far exceeds that of any previous year, and it appears also from a cursory comparison with the maximum year's observations, as recorded by Hofrath Schwabe, that the magnitude of the different groups, as well as the average amount of spotted surface during any period of the year, is unprecedented." (*Monthly Notices*, vol xxxi. p. 79, Warren de la Rue, B. Stewart, B. Loewy.)

The table which the authors of this paper give shows that during the year, although observations of the sun were made on 213 days out of the 364, there was no day without spots recorded. In fact, during the whole year no less than 403 new groups ol spots were noted, thus showing us that on the average there was more than one new group per diem.

The authors further remark, "A very remarkable feature of the groups observed during the year appears to be their extraordinary lifetime. . . an exceedingly large number of groups completed 3, 4, and even more revolutions before finally collapsing."

[5] "On the Relations of Weather to Mortality, and on the Climatic Effect of Forests."

The variations in the intensities of the pulses of rain at the successive maxima and minima are very remarkable, and suggest the working of a higher law, of which we have other evidence. But, putting this aside for the present, it should be pointed out that even normally we should not expect the same values for the rainfalls in 1882 and 1893, because the amount of spotted area was so different, 1160-millionths of the solar surface being covered with spots in 1883, and 1430 in 1893.

The very considerable variation in the quantity of snowfall on the Himálayas has often been pointed out by the Indian meteorologists. We have, therefore, used the "whole India" curve between 1875 and 1896, to see whether the sun pulses, which we have found to be bound up with the Indian rainfall, are in any way related to the snowfall as might be expected.

The Himálayan snowfall beyond all question follows the same law as the rain, the values occurring at the + and − pulses, as under, being among the highest :—[1]

		inches
−	1867-8 ...	134
+	1871-2 ...	110
−	1877-8 ...	207
+	1882-3 ...	81

From these tables it follows that both in rainfall and snow the quantity is increased in the years of the rise both of the unknown and iron lines.

Other Rainfalls.

Being in presence of pulses of rainfall in India during the south-west monsoon, corresponding with pulses of solar change, it became necessary to attempt to study their origins. We may add that other pulses were traced, especially one in 1875, but the simplest problem was considered alone in the first instance.

The rainfalls at the Mauritius, Cape Town and Batavia were collated to see if the pulses felt in India were traceable in other regions surrounding the Indian Ocean to the south and east.

The Mauritius Rainfall.

The rainfall of Mauritius has been obtained by utilising the results that have been published in the Blue Books [2] issued by the Royal Alfred Observatory since the year 1885. The volume for 1886 gives the yearly total rainfall for every station that was then in use from 1861 up to the year 1885, and these values have been employed ; since then the yearly values have been obtained direct from each of the yearly volumes subsequently published, *i.e.* to the end of the year 1898.

It was at first thought that the total Mauritius rainfall could be fairly obtained by employing for the period between 1861 and 1886 the means of several stations as given by Meldrum,[3] and continuing the values from the observations published in the more recent yearly volumes.

It was found, however, that from 1861–1880 the rainfall was obtained from the observations of four stations, while from 1871–1886 the observations from eight stations were employed.

As a study of all the published data showed that more stations might be utilised in determining the total rainfall of Mauritius, it was decided to discuss all the observations afresh, and make use of as many as possible.

To this end the records of twenty-eight stations, situated in six different districts, were chosen, and the total rainfall for each year obtained. It is only natural that the number of rain-gauge stations in the early year of 1860 was not so numerous as that of more recent years ; the facts may be stated as follows :—

Years.	Mean yearly rain-fall variation from normal	No. stations used.	Years.	Mean yearly rain-fall variation from normal.	No. stations used.
	Inches.			Inches.	
1861	+26·6	1	1880	−19·3	23
1862	−10·2	4	1881	− 7·3	25
1863	+ 9·6	6	1882	+16·6	25
1864	−12·2	8	1883	+ 1·8	26
1865	+22·6	10	1884	−12·4	25
1866	−18·2	10	1885	− 9·8	26
1867	− 6·6	11	1886	−35·3	26
1868	+27·1	11	1887	− 4·2	27
1869	− 3·3	12	1888	+22·3	26
1870	− 3·6	12	1889	+18·4	24
1871	−18·9	13	1890	+ 1·2	25
1872	− 7·0	13	1891	+ 1·4	26
1873	+10·3	13	1892	+ 5·1	19
1874	+17·4	17	1893	− 7·4	24
1875	+ 3·0	15	1894	− 0·6	24
1876	− 6·5	17	1895	+10·0	21
1877	+31·4	19	1896	+17·6	22
1878	− 3·8	22	1897	−19·6	24
1879	− 5·2	22	1898	− 2·1	24

With regard to the general rainfall of Mauritius throughout the year, it may be stated that on the average the most rainy months are from December to April, both months inclusive.

The months of November and May are those in which the daily rainfall is increasing and diminishing respectively. Sometimes in July or August there is a slight tendency for a small increase.

The Mauritius Rainfall Curve for the period 1877–1886.

In plotting the Mauritius rainfall curve for the period 1877–1886, it was observed that the curve is of a fairly regular nature, showing alternately an excess and deficiency of rainfall.

The highest and lowest points of the curve will be gathered from the following table :—

Year.	Maximum.	
	Excess.	Deficiency.
1877	31·4	—
1880	—	19·3
1882	16·6	—
1886	—	35·3

Comparing the times of occurrence of the two pulses of rainfall at Mauritius with the times of the crossings of the known and unknown lines, it is found that the Mauritius maximum rainfall of 1877 occurs about a year after the rise of the known lines in 1876. The next Mauritius pulse of rainfall in 1882 follows the succeeding crossing, when the unknown lines are going up, also about a year later.

Comparison of the Mauritius Rainfall with those of Leh, Murree and Newera Eliya for the period 1877–1886.

The most prominent feature of the Mauritius rainfall for this period was the great excess in the years 1877 and 1882.

1 *I.M.M.*, vol. iii. p. 235.
2 "Mauritius Meteorological Results."
3 1861–1880. Relations of Weather to Mortality, &c., 1881, p. 36. 1871–1886. Annual Report of the Director of the Royal Alfred Observatory for 1886, p. 18.

Both of these pulses have corresponding maxima in the curves for the rainfalls of Leh, Murree and Newera Eliya, the dates of these in all three cases being 1878 and 1882.

The delay of about a year in the effect of the Mauritius pulse being felt in Ceylon and India is exactly what would be expected if the rain at sun-spot minimum comes from the south, as has been surmised.

The fact that the pulses at Mauritius, Ceylon and India in 1882 occur simultaneously is very strong evidence in favour of an origin in the equatorial region itself for the Indian rain at sun-spot maximum. The pulse at maximum in the Indian south-west monsoon may depend to a large extent upon the action of the excess of solar heat on the equatorial waters to the south of India, and not on an abnormal effect on the south-east trade.

We have found that there was a defect of the usual rainfall at Mauritius in 1892–3, and yet the rain supply in India was in excess.

from time to time in the Southern Ocean. In his "Annual Summary" for 1896 he wrote as follows:—

"It has apparently been established in the discussion that the variations of the rainfall in India during the past six years are parallel with, and in part, at least, due to variations in the gradients, and the strength of the winds in the south-east trade regions of the Indian Ocean. The discussion has indicated that there are variations from year to year in the strength of the atmospheric circulation obtaining over the large area of Southern Asia and the Indian Ocean, and that these variations are an important and large factor in determining the periodic variations in the rainfall of the whole area dependent on that circulation, and more especially in India. It has also been indicated that these variations which accompany, and are probably the result in part of abnormal temperature (and hence pressure) conditions in the Indian Ocean and Indian monsoon area may be in part due to conditions in the Antarctic Ocean, which also

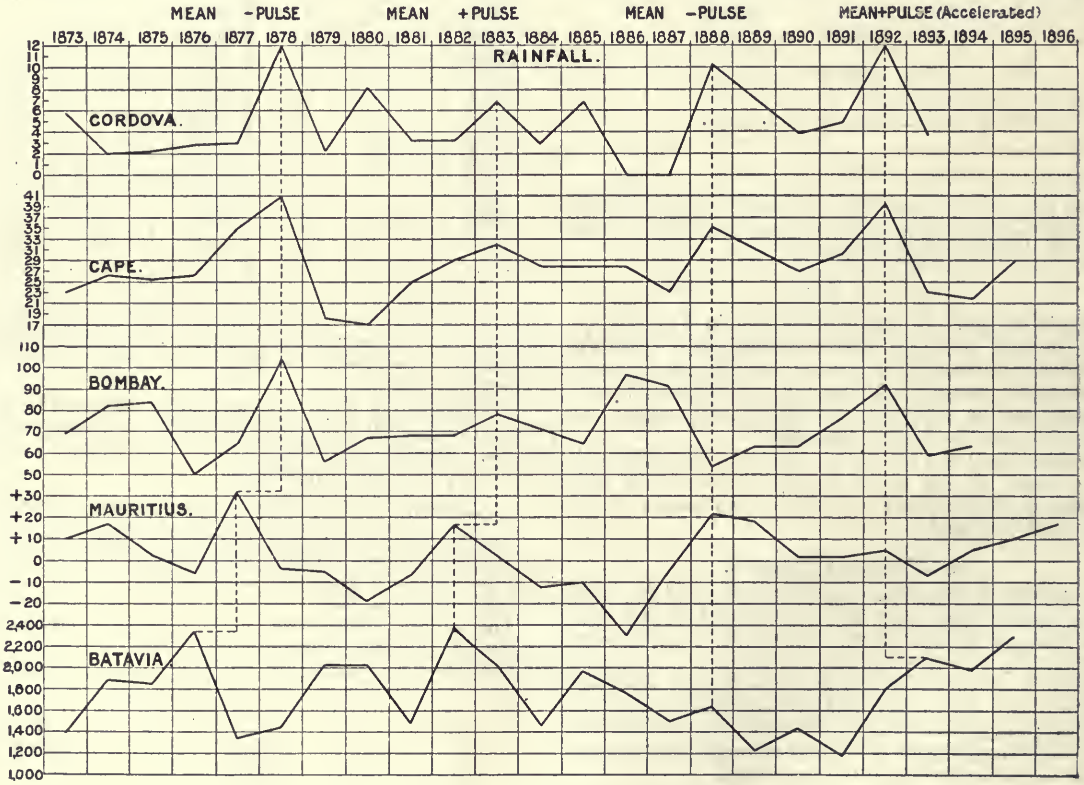


FIG. 1.

RESULT OF THE COMPARISON OF RAINFALL.

The + and – Pulses.

It seems quite certain that we are justified in associating the 1878 pulse of rainfall during the south-west monsoon in India with the rainfall common to Mauritius, Batavia and the Cape at that date; that in all cases the rain has been associated with some special condition connected with the south-east trade in the Indian Ocean.

The rainfall of Cordoba suggests that the same trade wind in the Atlantic Ocean was similarly affected at the same time.

The Cause of the – Pulse.

Mr. Eliot long ago conjectured that the rainfall of India was profoundly modified by events taking place

determine the comparative prevalence or absence of icebergs in the northern portions of the Antarctic Ocean."

We have begun an investigation into the pressure changes which have been recorded in this region, but it will be some time before it is finished. The idea underlying the inquiry is that the reduced solar temperature may modify the pressure so that the high pressure belts south of Mauritius may be broken up and thus allow cyclonic winds from a higher latitude to increase the summer rains as they certainly were increased at the normal minima of 1877 and 1888.

It has been shown that the – pulse is felt in India about a year later than it commences action in the southern oceans; while in some cases the + pulse is felt almost simultaneously in India and at the southern stations.

The Rainfall at the Cape, Batavia and Cordoba for the Period 1877–1886.

Each of the curves illustrating the rainfall for the Cape and Cordoba for this period shows two prominent maxima in the years 1878 and 1883; these correspond nearly with the + and − pulses of solar temperature. Comparing them also with the Bombay and Mauritius curves for the same period, it is found that the pulses indicated at Bombay occur simultaneously with those of 1878 and 1883, but in the case of Mauritius the effect of each of the pulses is felt about a year or so earlier, namely 1877 and 1882 (Fig. 1).

The rainfall curve for Batavia for this period has its most prominent maximum in the year 1882, like that of Mauritius, thus preceding by a year the pulse felt at the Cape, Cordoba and Bombay in 1883.

The Time Conditions of the Pulses.

The various curves which we have drawn for the purposes of study have been compiled from yearly means, generally to be the case. Thus after the mean solar temperature of 1876, the − pulse was felt first at Mauritius, then in India and the Cape. After the mean of 1881, the + pulse was felt first at Mauritius, then in India and the Cape. Cordoba felt both pulses in the same year as India and the Cape.

Subsidiary Pulses.

In a normal sun-spot curve we find a sharp rise, generally taking three or three and a half years, to maximum, and a slow decline to minimum, on which the remaining years of the cycle are spent.

The curve on the upward side rises generally regularly and continuously; on the downward portion the regularity of the curve is very often broken by a "hump" or sudden change of curvature. There has not yet been a complete discussion of the number and character of the prominences associated with the spots during the cycle; we have found, however, that the "hump" in the sunspot curve in 1874 was accompanied by a remarkable increase in the number of eruptive prominences.

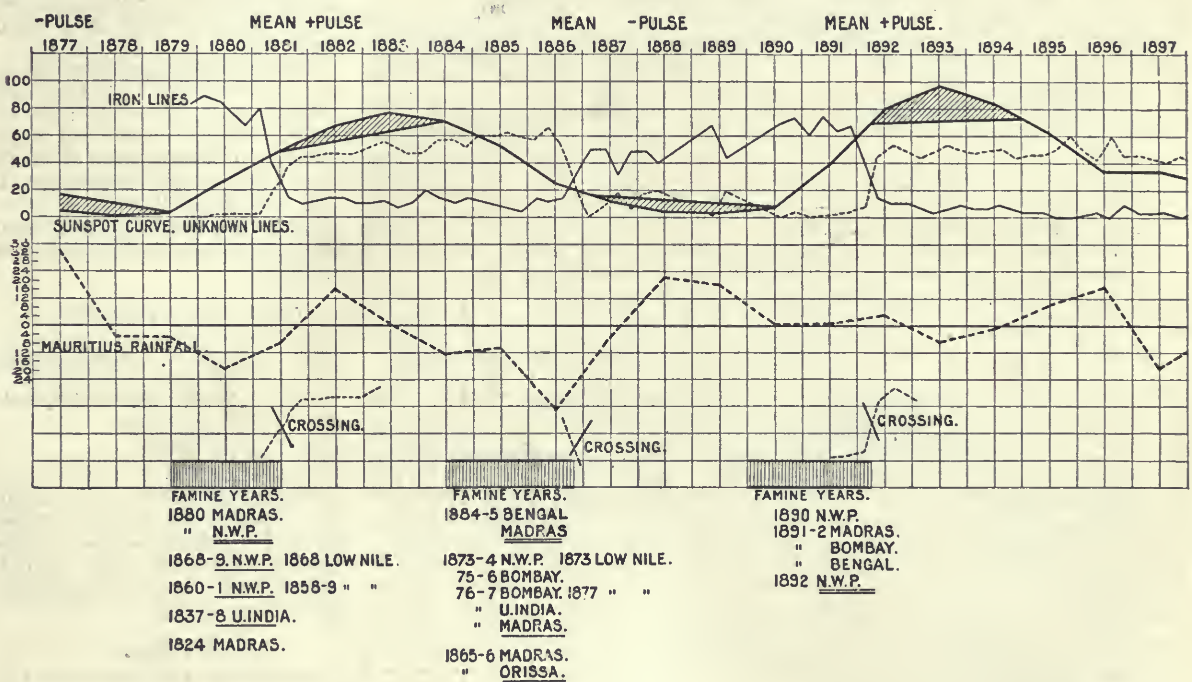


FIG. 2.

and, so far, in these curves the rainfall in months has not been considered. That will have to come later. Hence if the rainfall which most influences the yearly mean occurs in the last three months at one place, and in the first three months of the next year at another, they are shown as being a year apart, whereas they have actually been continuous.

With regard to the travel of the pulses over large areas under the influence of the S.E. trade, it may be gathered from the pressure charts that the + and − conditions of pressure are apt to lie over the centres of land and water areas, and not generally over coast lines. In the case of water surfaces, the effect of a sudden change in the solar radiation on the pressure might be expected to be felt not at the point where the pressure is least or greatest at the time, and of the most general type, but where the equilibrium is most unstable. On the other hand, more time would be required for the new pulse to establish itself where the conditions are more complicated.

Hence we should expect the pulses to be felt first in the eastern part of the southern ocean, and this seems

We have already referred, in discussing the Indian rainfall, to a remarkable intensification of the south-west monsoon in 1874–5, the effect of which is especially noticeable in the rainfall of the Konkan and North-West Provinces, and we have come to the conclusion that we must consider all these events as due to a common cause, that is, to a subsidiary solar pulse. We propose to return to this subject in a subsequent communication, after inquiries have been completed relating to 1885–6 and 1896–7.

The Intervals between the Pulses.

There will obviously be intervals between the ending of one pulse and the beginning of the next, unless they either overlap or become continuous.

The + and − pulses, to which our attention has been chiefly directed, are limited in duration; and when they cease the quantity of rain which falls in the Indian area is not sufficient without water storage for the purposes of agriculture; they are followed, therefore, by droughts, and at times subsequently by famines.

Taking the period 1887–89 we have (Fig. 2)

Rain from − pulse	77, 78, 79 (part)
No rain pulse	79 (part), 80 (central year), 81 (part)
Rain from + pulse	81 (part), 82, 83, 84 (part)
No rain pulse	84 (part), 85, 86 (central years), 87 (part)
Rain from − pulse	87 (part), 88, 89

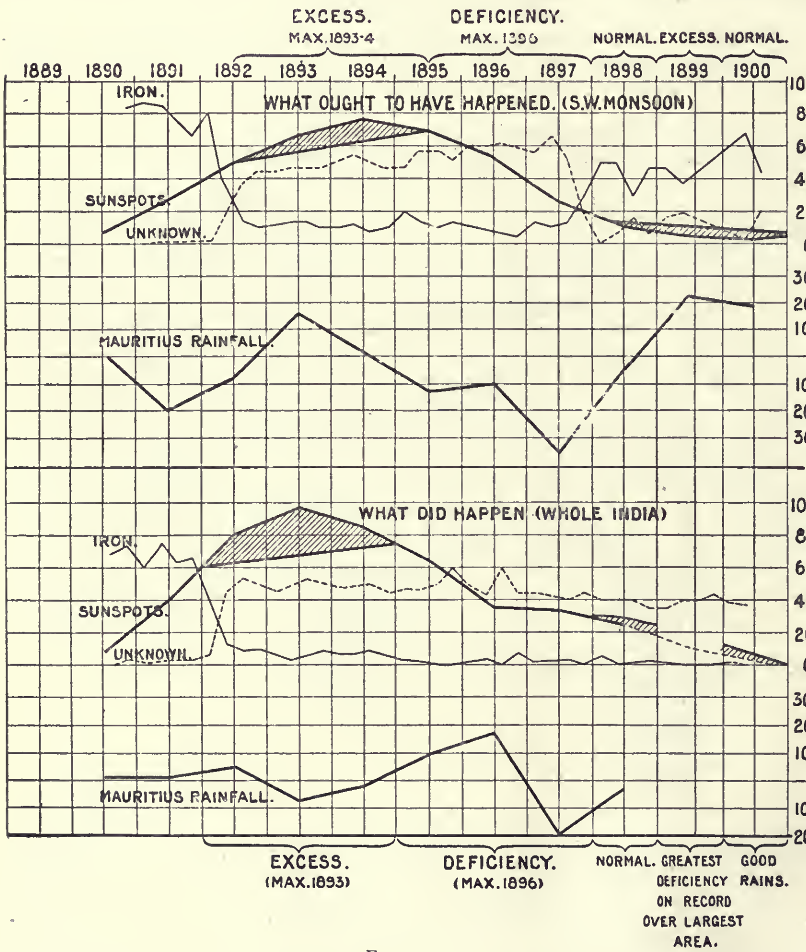


FIG. 3.

The duration of these + and − pulses of rainfall was determined in the first instance by the Mauritius rainfall, which shows both pulses; and later from the Malabar rainfall, which perhaps shows the effect of the south-west monsoon in its greatest purity.

All the Indian famines since 1836 (we have not gone back further) have occurred in these intervals, carried back in time on the assumption of an 11 year cycle.

The following tables show the result for the two intervals:—

The interval between the pulses, taking 1880 *as the central year, on the upward curve.*

1880, Madras famine.
N.W.P. famine.
1880 − 11 = 1869, N.W.P. famine (1868-9).
1869 − 11 = 1858, N.W.P. famine (1860).
1858 − 11 = 1847.
1847 − 11 = 1836, Upper India famine (1837-8). (Great famine).

The interval between the pulses, taking 1885-6 *as the central years, on the descending curve.*

1885-6 {Bengal famine, Madras famine} (1884-5).
1885-6 − 11 = 1874-5, N.W.P. famine (1873-4).
Bombay famine (1875-6).
{Bombay famine, Upper India famine} (1876-7).
1874-5 − 11 = 1863-4, {Madras famine, Orissa famine} (1865-6).
1863-4 − 11 = 1852-3, Madras famine (1854).

It is clear from the above table that if as much had been known in 1836 as we know now, the probability of famines at all the subsequent dates indicated in the above tables might have been foreseen.

The region of time from which the above results have been obtained extended from 1877 to 1886. The next table will show that if the dates, instead of being carried back, are carried forward, the same principle enables us to pick up the famines which have devastated India during the period 1886-97.

Same intervals, going forward.

1880.
+11 1891, N.W.P. famine (1890).
{Madras famine, Bombay famine, Bengal famine} (1891-2).
1885-6
+11 1896-7, General famine.

This result has arisen, so far as we can see, from the fact that the + and − pulses included in the period 1877-1886 were normal, that is, were not great departures from the average.

Nile Floods.

After we had obtained the above results relating to the law followed by the Indian famines, we communicated with the Egyptian authorities with a view of obtaining data for the Nile Valley.

We have since found, however, from a memorandum by Eliot,[1] that Mr. Willcocks, in a paper read at the Meteorological Congress at Chicago, remarked that "famine years in India are generally years of low flood in Egypt."

It remains only for us, therefore, to point out that the highest Niles follow the years of the + and − pulses. Thus:—

1871, one year after + pulse 1870.
1876, two years after subsidiary pulse of 1874.
1879, two years after − pulse 1877.
1883-4, one and two years after + pulse 1882.
1893-4, after + pulse 1892 (India excess rainfall, 1892-3-4).

[1] Forecast of S.W. Monsoon rains of 1900.

The Great Indian Famine of 1899.

When, in a sun-spot cycle, the solar temperature is more than usually increased, the regularity of the above effects is liable to be broken, as the advent of the – pulse is retarded.

This, as we have already pointed out, is precisely what happened after the abnormal + heat pulse of 1892, following close upon the condition of solar mean temperature.

The widened line curves, instead of crossing, according to the few precedents we have, in 1897 or 1898, have not crossed yet—that is, the condition of ordinary solar mean temperature has not even yet been reached.

We have shown that, as a matter of fact, in a normal cycle India is supplied from the southern ocean during the minimum sun-spot period, and that this rain is due to some pressure effect brought about in high southern latitudes by the sun at – temperature.

As the – temperature condition was not reached in 1899, as it would have been in a normal year, the rain failed (Fig. 3).

We may say then that the only abnormal famine recorded since 1836 occurred precisely at the time when an abnormal effect of an unprecedented maximum of solar temperature was revealed by the study of the widened lines.

TABLE

Showing the Occurrence of the + and – Rainfall Pulses in other parts of the World.

	+ 1870	– 1877	+ 1882	– 1886	+ 1892
Batavia ...	—	1876	1882	1888	(?)
Mauritius ...	—	1877	1882	1888	1892
Catherinenburg (Russia)	—	1877	abs.	1887–8	1892
Scotland ...	—	1877	—	—	1892
Copenhagen ...	1872–3	1877	1882	1888	1891
Adelaide ...	1870	1877	1883	1889	1892–3
Tifilis	1870	1878	1881	1886–90	1893
Archangel ...	1872	1878	1881–2	1887–8	1892
Brussels ...	—	1878	1882	1888	1892
Hobart Town ...	—	1878	1882	1887	1893
Malabar [1] ...	1871	1878	1882	1888	1892
Toronto ...	1870	1878	1883	1886	1893
Cordoba (Arg.)	—	1878	1883	1888	1892
Cape	—	1878	1883	1888	1892
Java	1872	1879	1882	—	1893
Barnaul (Russia)	1872	1879	1882–3	1887	1894
St. Petersburg	1871	1879	1883	1888–9	1893
Nile	1871	1879	1883–4	—	1893–5

[1] For comparison.

THE BRADFORD MUNICIPAL TECHNICAL COLLEGE.

PROF RÜCKER recently distributed the prizes at the Technical College at Bradford, which was taken over by the municipality a year ago, and is now controlled by a Committee of the City Council. The following is an abstract of his address:—

It would be trite to dwell at length on the changes which have taken place in the educational standards during the last quarter of a century. Then Mr Forster's Education Bill had only been in operation for five years. Now we have free elementary education, and a large sum has been provided for technical education. Two new Universities have been founded and a third, after fifty years' examining, is at length about to teach. Education is not now regarded as the task of a few dons and professors and schoolmasters. It is a matter which the Cabinet discusses, together with the issues of peace and war, and with the federation of daughter States into a Commonwealth. Nay, and in the great spread of local self-government, when Town Councils decide questions which affect more people than constituted, in the beginning of the century, many an independent German State, education is not forgotten; and here in Bradford you have the whole authority and power of your great municipality brought to bear to form a technical school which will support the industries on which your prosperity depends.

And yet, gentlemen, in the midst of all this eager and fruitful effort how difficult it is to decide what the ideal system of education should be. For in any such system two things must be considered, the welfare of the individuals taught and the welfare of the community of which they are a part; and at first sight these two do not always seem to be identical. Each man, the State may say, has a task to perform, which, if he performs it well, is for the good of the community, and, provided he is a good citizen, I care only about his special task. This man may have to dispense justice. My only concern is that he should be a just and learned judge. That man is to be a manufacturer. If he manufactures well, that is all the State need care for. But surely this view only needs stating clearly to show that there must be a fallacy somewhere. Like the old political economy, it assumes that man lives by bread alone. At the best he cannot always be working, and his own happiness—aye, and the good of the State, too—may be affected by whether his amusements are refined or low, upon whether they elevate or debase him. From this point of view the best educators would be insects, which, like ants or bees, have developed special forms of workers, or soldiers, or drones; or even, as is, I believe, the habit of one species, use an individual to store their food till it becomes a mere bloated honey-bag.

Others hold the opposing view. The object of education, they say, is to educate—that is, to bring out the latent capacities of the mind. Provided this end is achieved, it matters little how this is done; but, on the whole, it is better that the subjects taught should be selected rather because they illustrate general principles than because they are likely to be immediately useful. This ideal is to be condemned because it is impracticable for all but the few. It never has been the system adopted for the working man, and has been very imperfectly adopted for the great bulk of the commercial and professional classes. In the stress and struggle of modern life it is becoming more and more difficult to adopt it for anybody, and common sense revolts against the idea that the utility of the subject taught, or of the method of teaching it, is of secondary importance.

We come, then, to the conclusion that the truth lies somewhere between these two extremes, and that the best education is that which will prepare a man for his walk in life, and will also, as far as may be, keep his mind open to interests and ideas other than those upon which his success as a bread-winner directly depends.

I will not attempt, in the short time at my disposal, to sketch out a general system of education in which these conditions would be fulfilled, and, if I did, I should throughout be conscious that I was only throwing an apple of discord among educational experts.

But, taking scientific and technical education as a whole, I am clear that for the better students, at all events, the study of science should be relieved and aided by the study of modern languages.

Nowadays everything is becoming more cosmopolitan. Science is becoming more international. Only this summer I attended the first meeting of a new association of all the great scientific academies of the world. Again, with the new century will begin the publication of an

international catalogue of scientific literature, in which all scientific memoirs and publications will be catalogued.

I quote these instances as they are those which have fallen more immediately under my own observation, but manufacturers can tell a similar tale. The visit of the Iron and Steel Institute and of the Institution of Electrical Engineers to Paris, the visit of the Electrical Engineers to Switzerland, and the travels of the Naval Architects all show that the great professions are becoming more and more international. It is essential that a young man who intends to keep abreast of what is being done abroad should be prepared to read foreign periodicals, and to make the most of any opportunity which may occur of going abroad himself. To do this he must study modern languages. This will be directly useful, and it will also have the great educational advantage that it tends to keep alive an interest in something other than the science or technology to which I am supposing that the attention of the student is chiefly turned.

As matters stand at present, a number of the most intelligent of our youth, after the more elementary parts of their education are completed, devote themselves chiefly to science. Many of the best of them come under my personal observation in the Royal College of Science. Some of them develop such marked scientific ability that they pursue the more theoretical side of their studies, and aim at taking a degree with honours. Their education has often been carried on chiefly by means of State or municipal grants made to the schools or colleges in which they have been educated. In the system of education under which they have been brought up, no effort has been made to induce them to study classics. Yet when they have proved themselves worthy of a high University training in science, they are suddenly stopped in the middle of their career, and told that no further progress towards a degree is possible unless they go back to school again and learn the Latin grammar. I think that the time has come when this should be changed, and a knowledge of modern languages should be allowed to replace Latin.

The hard and fast line of separation which has too often been drawn between the earlier education of those who do and of those who do not propose to go to the University would thus be obliterated. Both should be taught modern languages, both should be taught science, and both would then have acquired a literary and scientific training which could be developed in the further stages of a technical or a University education.

Do not misunderstand me. I am not advocating the abolition of the system of classical education which is predominant in the public schools. But it is too often forgotten that there is another great system of education growing up side by side with that which is based on classics. This system is based on a knowledge of science. The study of classics is introduced into it neither at the beginning as a foundation nor at the end to complete it. It is introduced as a patch in the middle. Of two things one. If Latin is essential, let the State and the municipalities supply funds for it as lavishly as they do for science. If it is not essential, do not insist on introducing it at the most inconvenient moment of the student's career.

But if I would take away something from the burden now laid on beginners, I would also modify the later stages of scientific or technical education.

Up to the present the general training of students of science at the University has ceased with their matriculation. The modicum of Latin which they have then obtained, with a little history and geography, and perhaps some French, is abandoned. The University takes no further note of their progress in these subjects. If I am in favour of ceasing to make Latin compulsory, I also desire that the more advanced students of science or industry should carry on the study of modern languages, which should be regarded as an integral part of a scientific education. Too exclusive attention to one subject would thus be less probable; but nevertheless the student would be directed to what he himself would regard as matter germane to the central interest of his life, for a knowledge of French and German is essential to the proper cultivation of science. These views I have long held, and I am glad to learn that they are very similar to, if not identical with, the views of Lord Rosebery. If the politicians determine on the reform it will become a practical question.

But though anxious that this reform should take place, I am well aware that the matter of immediate, pressing and vital importance for our national welfare is that the knowledge of science should not only be more widely spread among us, but also that the scientific method should be more widely applied to industry.

I have no intention of attempting to read Bradford a lesson on business methods. But you will allow me to congratulate both the scientific and the business worlds on the fact that they are drawing nearer together. A profound knowledge of the secrets of nature may be combined with knowledge of the world, while the business man is often a highly cultivated scholar, and is learning the lesson that he who is quickest to apply new knowledge to old problems is most likely to win and to keep the markets of the world.

Day by day the workshops are growing more and more like scientific laboratories, except that the appliances are on a scale which few laboratories have the means to command. On the other hand, the laboratories are becoming more and more like the homes of scientific industry.

Germany has for some years had a national physical laboratory—the Reichsanstalt—in which scientific questions likely to be useful to industry are investigated. The organisation for which that country is remarkable, and in which we are deficient, was shown by the way in which the scientific exhibits at the Paris Exhibition were dealt with. Those of our scientific instrument makers who sent specimens of their work, each selected and exhibited what seemed to him good. Their exhibits were distinct and separate, and the English exhibit as a whole was a patchwork, with no well-defined scheme or pattern. In Germany the scientific exhibit was supervised by the officials of the Reichsanstalt. Instruments of the same class were exhibited together, whoever their maker might be; and the visitor could see at a glance the best that Germany could produce of each particular type. Assistants were ready to open the cases and to display the wares. Catalogues of the different firms were furnished if the visitor signed a written request, and a central office had been established where orders could be booked. This, of course, was an exceptional piece of work, but the general uses of a national laboratory are permanent; and, owing to the efforts of the British Association and the Royal Society, the Government have lately asked the Royal Society to undertake the management of an institution similar to the Reichsanstalt. The sum granted is very small, as compared with the resources of the German institution, but I do not quarrel with that decision. If the thing is good it will grow, and it is perhaps better not to begin on too large a scale. A year ago we were ready to get to work. Six of the great technical societies are represented on the governing body. Committees have formulated a scheme of work, but grave delay has been occasioned by opposition to the erection of the laboratory at Richmond.

But, gentlemen, putting our difficulties aside, I believe that the foundation of a National Physical Laboratory, and the establishment of a municipal technical school at Bradford are both signs of the growing recognition of the ties between science and industry; and I take it as

another sign of the same fact that the heads of this great technical college have asked me, a student of pure science, to distribute your prizes to-night. I should be misusing the opportunity you have given me if I did not assert the conviction, common both to you and me, that it is by means of the scientific study of various industries, study such as you here carry on, and such as will be carried on in the National Physical Laboratory, that trade and science alike will prosper.

The first nuggets in gold-bearing districts are often picked up upon the surface; but mines can only be worked on a large scale by organised industry. As we penetrate deeper into the secrets of nature, as the industrial struggle grows keener, the rough and ready methods of the past will not win either knowledge or wealth.

We cannot afford to dispense with the old virtues. If we become slack and idle, if we devote to sports, innocent and useful in their place, the energy and attention which others are giving, not to the amusements, but to the business of life, we shall be, as we shall deserve to be, beaten. But to the old virtues we must add new methods, and among these none seems to me more praiseworthy than that a great municipality should determine that the lads who embark on the principle industries of the town shall have an opportunity of mastering the scientific principles on which those industries are based, and shall be shown, as they master them, how the principles are to be applied to the business of life.

THE ALLIANCE BETWEEN SCIENCE AND INDUSTRY.

LAST September Prof. Carhardt communicated to the American Institute of Electrical Engineers a very complete account, which has recently been printed in *Science*, of the Reichsanstalt at Berlin. He had worked there as a guest for some months in 1899, and had thus gained an insight into its management and organisation. The details he gives of these are very interesting, and the proof of the value of the work done, and of its consequences to German industry, most striking. The cost of the Institution, we may note, was about 200,000*l.*; the annual expenditure amounts to about 15,000*l.* After mentioning these figures he continues, "A very pertinent inquiry is, what are the results of all this expenditure?" and a careful analysis leads him to the conclusion that, "The results have already justified, in a remarkable manner, all the expenditure of labour and money. The renown in exact scientific measurements formerly possessed by France and England has now largely been transferred to Germany. Formerly scientific workers in the United States looked to England for exact standards, especially in the department of electricity, now they go to Germany." And again, "Germany is rapidly moving toward industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism and the failure to utilise to the fullest extent the lessons taught by science."

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held as usual on St. Andrew's Day, November 30, in the apartments of the Society at Burlington House. The auditors of the treasurer's accounts having read their report, and the secretary having read the list of Fellows elected and deceased since the last anniversary, the president (Lord Lister) proceeded to deliver the anniversary address. After referring to the losses by death sustained by the Society since the previous anniversary, and briefly noticing the work and careers of the deceased Fellows, the president continued his address as follows:—

Through the Malaria Committee the Society has kept in touch with the progress that has been made in unravelling the mystery of the greatest scourge of our tropical colonies, and with the steps that advancing knowledge has suggested for its suppression. The subject has now reached a stage at which it may be not unfitting to refer briefly to what has been accomplished.

The term "malaria" implied the belief that some vitiated state of the atmosphere was the cause of the disease. But the knowledge gained of late years of the parasitic nature of infective disorders pointed clearly to such an origin of the intermittent fevers, as the various manifestations of malaria have been termed. Accordingly diligent and long-continued search was made in the water and the soil of malarious districts in Italy for the suspected living agent, but without success. The discovery was made in 1880 by Laveran, a French army surgeon stationed in Algiers, who observed in the red blood corpuscles of malarious patients what he regarded as adventitious living organisms; not of vegetable nature like the bacteria which constitute the *materies morbi* of so many infective diseases, but a very low form of animal life. In what he believed to be the youngest condition of the organisms, they appeared in the red blood-discs as tiny specks of colourless protoplasm, possessing amœboid movements. These, growing at the expense of the red corpuscles which they inhabited, consumed them more or less completely, at the same time depositing in their own substance a peculiar form of dark brown or black pigment, such as had long been known to form characteristic deposits in the organs of malarious subjects. As they grew they assumed various forms, among which was what Laveran termed the "rosace," a rounded body bearing at its circumference little spherules, while the pigment was accumulated at the centre (*vide* Laveran, Du Paludism, Paris, 1891).

This discovery of Laveran's, at first regarded with the gravest suspicion by pathologists, was the first great step in the etiology of malaria. It supplied the means of distinguishing the disease from its counterfeits, and it explained the wonderful specific efficacy of quinine, till then given only empirically. Quinine is remarkable in the circumstance that it acts with deadly effect upon some microbes, in dilutions which are quite unirritating to the human tissues. It can thus be given in sufficient doses to kill the malaria parasite in the blood without injuring the patient.

Nine years after Laveran's discovery, Golgi, of Pavia, who had been specially studying the "rosace" form of the parasite, and who had become convinced that the spherules at the circumference of the rosace were sporules of the microbe, announced that he had observed differences between the rosaces of the tertian and quartan forms of the fever so great and so constant as to make him satisfied that they were two distinct species of organism. At the same time he had made the extremely important observation that the periods of occurrence of the fever corresponded with the times of maturation of the rosaces. These, all coming to maturity about the same time, shed their sporules into the blood, and this determined the febrile attack. The free sporules then, according to his view, attached themselves severally to other red discs, constituting Laveran's tiny amœbæ, and grew in the red copuscles without causing symptoms till they had produced a fresh crop of sporules ripe for extrusion, the time for this being two days in the tertian and three days in the quartan form. Thus the periodicity of the intermittent fevers and their variety in that respect were alike explained. (*Vide* Laveran, *op. cit.*)

A few months later a third species or the parasite was recognised, having the peculiarity that some of its individuals, instead of being of rounded form, were of crescentic shape. This species received the title æstivo-autumnal, on account of the season in which it showed itself in Italy. It was not so regular in its periods as the others, and was much more dangerous. The existence of these different species was at first very generally doubted, but it is now universally accepted and is of very great importance. The examination of a drop of blood from the finger of the patient enables the physician to decide, not only whether the disease is malaria, but which of the three types it will follow. The more dangerous crescent form is commonest in the tropics, and hence has been termed by Koch

tropical malaria. The quartan has proved the mildest of the three.

The process of sporulation might seem at first sight to explain the whole life-history of the parasites. For their propagation within the human body that process does indeed make ample provision. But the mystery remained—how did they gain entrance into the human system? Though present in abundance in the blood of the malarial patient, they are absent from the excreta. Spontaneous generation having been long since exploded, what could be their mode of origin in the external world? This problem has of late been completely solved.

Among the forms of the parasite observed by Laveran was one which he termed "flagellated," possessing filamentous appendages which exhibited extremely active movements, by virtue of which they were often seen to break off from the parent microbe and swim away. These flagella were regarded by many biologists as products of degeneration resulting from the abnormal influences to which the parasites were exposed in blood outside the body. This Laveran could not believe: indeed, it was the remarkable activity of the flagella that finally satisfied his own mind that what he had discovered were really living parasites: he regarded the flagella as the highest form of development of the microbe. There was another observer who felt equally convinced that the flagella were living elements—our Fellow, Dr. Manson. He, however, went a step further. Seeing that the flagella were never met with in blood when first drawn, but only made their appearance after some little time had elapsed, he conceived that their function must be that of spores for spreading the parasite in the external world, and some suctorial insect seemed to him the probable agency for their diffusion. He had observed several years ago that another parasite of the human blood, a microscopic nematode worm, Filaria, is drawn with the blood into the stomach of a kind of mosquito, and finds in the insect a secondary host, in the tissues of which it passes through a new cycle of development. He became deeply impressed with the idea that a similar series of events might occur with malaria, and he expounded his views fully before the College of Physicians. The notion that mosquitoes might be in some way associated with malaria had occurred to Laveran and to others, but by no one had it been brought home with such logical force as by Manson.

Major Ronald Ross, of the Indian Medical Service, on a visit to this country, became deeply impressed by Manson's arguments, and determined to test his theory on returning to India. Using mosquitoes bred in bottles from the larva, he caused them to bite persons affected with the crescent form of malaria, and afterwards sought in the bodies of the insects for evidence of the development of the parasite within them. For two long years he pursued this search, making about a thousand observations, but to no purpose. So far he had employed two kinds of mosquito common in the district where he was stationed; but in August 1897, having been supplied with some larvæ of a species rare in that locality, and having bred the fully developed insects from them, he induced eight of them to bite a patient with crescents in his blood, and examined their tissues at successive periods. Four of them were killed at once for the investigation of the flagellated bodies. Of the remainder, one examined four days after biting showed, under a high magnifying power, several rounded bodies imbedded in the wall of the stomach, differing from any natural structure of the insect, and containing granules of pigment "identical in appearance to that of the parasite of malaria" (*vide British Medical Journal*, December 18, 1897). The eighth mosquito was killed one day later, and exhibited bodies precisely similar except that they were distinctly larger and more substantial, implying that they had grown in the interval. Thinking that in all probability he had at length found that which he had been so long in search of, and feeling uncertain when he might again obtain the rare species for confirmatory investigation, he at once sent a description of his observations to London, accompanied by his preparations and an independent report upon them by a colleague. Dr. Manson, to whom, among others, they were submitted, was so much struck with the preparations that he had a drawing made of the pigmented bodies in them for publication along with Ross's paper. Though, like Ross, expressing himself with caution, he inclined to his interpretation of the appearances. The paper contained a minute description of the rare mosquito, which seemed to Ross to belong to a "family distinct from the ordinary" kinds.

In the following month he made a similar experiment with another species of mosquito which appeared closely allied to the subject of his last observations. He succeeded, though with some difficulty, in getting two of them to bite a patient with crescents. One of these insects, killed next day, was examined with a negative result; but in the second, killed forty-eight hours after biting, the peculiar pigmented bodies were again seen among the tissues of the stomach. Meanwhile, "some scores" of the species, "unfed or fed on healthy blood, had been examined without finding the cells."

In the same month he observed precisely similar pigmented bodies in a common mosquito which he had seen feeding on a patient affected with the parasite of mild tertian fever. Here he had not the rigorous evidence supplied by insects bred from the larva;[1] and it was quite a new thing to find the pigmented bodies in ordinary mosquitoes. But all the patients on whom his previous observations on the common species had been made had been affected with crescents; and the parasite concerned being in this case a new species, it did not seem unlikely that it might be harboured by the common insects.[2] These new facts removed all doubt from his mind; and he felt that he had the subject in his grasp, and wrote to that effect to Manson. But, to his bitter disappointment, he was at this time despatched to another part of India to study another disease; and thus several precious months were lost.

In February 1898, however, he was told off for the special investigation of malaria, and a laboratory in Calcutta was set apart for his use.[3] Few cases of human malaria being available at that season of the year, he turned his attention to some closely allied forms of disease common in birds. He soon found that one of the ordinary kinds of mosquito, which had invariably given negative results when fed on patients with crescents, developed pigmented bodies among the tissues of the stomach if fed on birds, such as sparrows, containing in their blood the form of bird parasite known as Proteosoma. The birds presented a ready field for experiment; and the kind of mosquito, the grey mosquito as he termed it, was very abundant in Calcutta, so that it was easy for him to hatch from the larva any number that he might require. Discoveries now followed each other in quick succession. He soon announced that the pigmented bodies grew rapidly from day to day, till after about a week they assumed large proportions, projecting like buttons from the outer surface of the stomach, and often showing a curious appearance of radiating striæ. Next we learned that the striæ had been indications of spore formation, and that when the bodies had attained maturity they burst into the general body-cavity, discharging enormous numbers of minute elongated organisms which he termed "germinal rods." Then followed the remarkable observation that the germinal rods soon leave the general body-cavity, and accumulate in the cells of the salivary or poison glands and in the duct leading from them to the proboscis, with which the bites of the insect are inflicted. And, lastly, he completed the cycle of evidence by ascertaining that healthy sparrows could be infected with the Proteosoma by causing mosquitoes to bite them at the appropriate period after biting an infected bird.

Thus was, in truth, established the mosquito theory of malaria. For taking into account the close resemblance of the Proteosoma to the parasites of human malaria, together with the facts ascertained by Ross regarding the infection of the rare mosquitoes with human crescents, we could not doubt that the course of events which he had traced in the sparrow occurred also in man. And the two sets of observations, taken together, clearly established the fact that, as Manson had predicted, different species of malarial parasite may require different kinds of mosquito as their alternative hosts.

At the same time, the presence or absence of the pigmented bodies in the stomach wall afforded a sure means of distinguishing those kinds of mosquitoes which convey malaria to man from those which are incapable of doing so. And it may be added that the multitude of negative results after feeding grey mosquitoes with crescent blood, considering the great prevalence

1 *Vide British Medical Journal* (February 26, 1898). In this second paper Ross did not repeat the description of his method, given in the former article, of using mosquitoes bred in bottles from the larva. But as that had been his practice for more than two years, there can be no reasonable doubt that he continued it with this new species. I have also his personal assurance that such was the case.

2 As the result of further knowledge, there is no doubt that this common mosquito had derived its pigmented bodies, not from the man it was seen biting, but from a bird affected with another species of malarial parasite.

3 It has seemed necessary to refer to these points in detail, as considerable misapprehension has prevailed in some quarters regarding them.

in Indian birds of the parasite with which that species of insect is liable to be infected, afforded pretty conclusive evidence that the mosquito never derives the germs of malaria from the larva and can acquire them only by biting some infected animal.

But although the mosquito theory was thus demonstrated, there remained a link wanting in the chain of biological sequence. The flagella which Manson regarded as spores were destitute of malarial pigment, whereas the smallest corpuscles seen by Ross in the stomach wall invariably possessed it. How was this inconsistency to be explained? What was the relation of the unpigmented flagellum to the pigmented corpuscle? The answer had been already independently supplied.

I was present at a sitting of the Zoological Section of the British Association at the Toronto Meeting in 1897, when Dr. MacCallum, a young pathologist of the Johns Hopkins University at Baltimore, read a paper describing the results of an investigation in which he had long been engaged into another form of malaria parasite, Halteridium, especially common in crows. He told us, and he illustrated his statements with preparations under the microscope, that he had distinguished differences, which he regarded as fundamental, between the spherical bodies seen in the shed blood of a bird affected with that parasite. Though alike in size, some had a more granular protoplasm than the others, which had a more hyaline aspect; and he had observed that the more hyaline ones alone emitted flagella. These, after wriggling themselves free from the parent cell, swam away till they approached some corpuscle of the other, more granular, sort; when the first that reached it plunged into its substance and disappeared, while all others were, by some amazing provision, absolutely refused entrance. Here, then, was witnessed, in an exceedingly low form of animal life, a process of fertilisation identical with that which occurs in an echinus or a fucus. The flagella were neither more nor less than spermatozoa, and the more granular cells were ova. As the result of the fertilisation, the female cell was seen by MacCallum to alter its shape in the shed blood and assume an elongated form to which the term vermiculus was applied. This new creature was possessed of wonderful powers of locomotion, sometimes in its powerful career piercing through the substance of a red corpuscle.[1] Nothing could well be imagined better adapted for penetrating the layer of cells that line the stomach of the mosquito; and as the vermiculus retained its pigment, Ross's pigmented bodies were naturally accounted for.

These observations of MacCallum's might seem at first almost too wonderful for credence; but they have been fully confirmed by others.

It appears to be doubtful whether Halteridium ever produces the "rosace" form, with its attendant sporulation; but there is no doubt that the process of fertilisation seen in that parasite occurs in human malaria. MacCallum himself observed the act of conjugation in the crescentic human form; though he did not see the subsequent development of the vermiculus. Koch made a further step by observing the vermiculus of Proteosoma in blood from the mosquito's stomach.[2] And, finally, our medallist Grassi, who in other ways has made most important contributions to this subject, has, in a recent work (*vide* Grassi, "Studi di uno Zoologo sulla Malaria," Roma, 1900), accompanied by very beautiful illustrations, not only described the presence of vermiculi in abundance in the blood in the stomach of mosquitoes during the first two days after biting patients affected with malaria, but he has traced and figured the pigmented bodies of the smallest size in the tissues of the stomach in the immediately succeeding period, these bodies retaining in some instances the elongated form of the vermiculus after passing through the layer of epithelium that lines the cavity of the organ.

It has thus been abundantly established that the parasites of malaria are present in the patient's blood in two distinct forms, one sporulating asexually in the human system and causing the attacks of fever, the other undergoing sexual development in the body of the mosquito. That both forms are developed from the spores introduced by the mosquito is certain. At what stage they begin to develop their respective peculiarities is not yet quite made out. The crescent form is peculiarly favourable for this inquiry, as it is the crescents only which discharge the sexual function; and they are easily distinguished from the sporulating kind, not only by their shape, but also by their much larger size.

The development of the crescents has been specially studied by the Italian pathologists, Bastianelli and Bignami,[1] who have been able to distinguish the young crescents while still of extremely small dimensions; and they have made the remarkable observation that, while the crescents are as a rule only found in the blood of the finger when they have arrived at maturity, the young forms are to be seen in internal organs, such as the spleen, but above all in the bone marrow, where alone, according to these observers, the youngest recognisable crescents are to be found.

Seeing that, in whatever part of the body they are, the parasites always inhabit the blood, it seems difficult to conceive what can be the cause of their preference, at different stages of their growth, for the blood vessels of different regions and organs. But of this we find parallels in several other cases of blood parasites, the most striking, perhaps, being the astonishing fact that, of two species of Filaria that infest the human blood, one only shows itself in superficial parts at night, and is therefore termed *Filaria nocturna*, while the other has the name *Filaria diurna*, because it only appears by day in the finger blood and retreats into deep parts for the night.

Ross was not an entomologist, and he was unable to learn in India the names of the species of mosquito with which he had been working, till Daniels, one of the explorers sent out by the Malaria Committee, having gone to Calcutta to confirm or otherwise Ross's work, informed him that his rare kinds, which acted as hosts for the human crescents, belonged to the genus Anopheles, and that the common sort which performed the same office for Proteosoma, belonged to another genus, Culex. It has been a matter of great interest to ascertain whether all mosquitoes which act as conveyers of malaria to man are of the genus Anopheles, and the exceedingly common and numerous species of Culex are guiltless in that respect. Very numerous investigations into this question, and especially those conducted by Grassi and his coadjutors, seem to have proved that such is the case, and that, so far as human malaria is concerned, Anopheles alone have to be considered.

Our other two explorers, Messrs. Christophers and Stephens, have made various important contributions to our knowledge of malaria. Thus, having paid special attention to the very dangerous disease which, on account of one of its symptoms, is termed blackwater fever, they have come distinctly to the conclusion that it is not a special disorder but a form of tropical malaria. If this is the case, it is of immense practical importance; for it will follow that any means efficacious for ordinary malaria will prove equally so for the deadly blackwater fever.

Another most important fact which they have ascertained, and which was independently observed by Koch, is that in a native population in a malarious region, while the adults may be perfectly free from the disease, the young children contain the parasites in their blood in an enormously large percentage. Though the disease appears to be much less dangerous to the native children than to new arrivals, implying that they have a degree of congenital immunity, the parasites in the young natives are perfectly efficacious for causing dangerous fever in white people when conveyed to them by mosquitoes. Hence the important practical inference that white people settling in a malarious tropical region should not, as they now commonly do, plant their houses near native settlements, but place them at some considerable distance from them, about a quarter of a mile being apparently sufficient. And Christophers and Stephens in their last communication have gone so far as to express the opinion that the following of this simple rule would go very far indeed towards rendering the malarious tropics healthy to Europeans.

In a communication to this Society, it is the scientific side rather than the practical that is naturally chiefly dwelt on. Yet I should have been glad, had time permitted, to have referred to the various measures of prevention and treatment of malaria which the light of recent knowledge has already suggested, and which have already borne important fruit. I must now content myself with saying that, very various as these measures are, they are all, without exception, based on the mosquito theory.

[1] *Vide* On the Hæmatozoan Infection of Birds, by W. G. MacCallum, M.D., *Journal of Experimental Medicine*, vol. iii. No. 1, 1898.

[2] *Vide* Ueber die Entwickelung der Malaria Parasiten, R. Koch, *Zeitschrift für Hygiene und Infectious Krankheiten*, Band xxxii., 1899. Exceedingly beautiful microphotographs of different kinds of malaria parasites in various stages of development accompany this article.

[1] *Vide* "Sulla Struttura dei Parassiti Malarici," per G. Bastiani ed A. Bignami. Società per gli Studi della Malaria, 1899.

The medals were then presented as follows :—The Copley Medal to Prof. Marcellin Berthelot, For.Mem.R.S., for his brilliant services to chemical science; the Rumford Medal to Prof. Antoine Henri Becquerel, for his discoveries in radiation proceeding from Uranium; a Royal Medal to Major Percy Alexander MacMahon, F.R.S., for the number and range of his contributions to mathematical science; a Royal Medal to Prof. Alfred Newton, F.R.S., for his eminent contributions to the science of ornithology and the geographical distribution of animals; the Davy Medal to Prof. Guglielmo Koerner, for his brilliant investigations on the position theory of the aromatic compounds; and the Darwin Medal to Prof. Ernst Haeckel, for his long-continued and highly important work in zoology, all of which has been inspired by the spirit of Darwinism.

The Society next proceeded to elect the officers and council for the ensuing year. The following is a list of those elected :—

President: Sir William Huggins, K.C.B.; Treasurer: Mr. A. B. Kempe; Secretaries: Sir Michael Foster, K.C.B., Prof. Arthur William Rücker; Foreign Secretary: Dr T. E. Thorpe; other Members of the Council: Prof. H. E. Armstrong, Mr. C. V. Boys, Dr. Horace T. Brown, Mr. W. H. M. Christie, C.B., Prof. E. B. Elliott, Dr. Hans F. Gadow, Prof. W. M. Hicks, Lord Lister, Prof. W. McIntosh, Dr. Ludwig Mond, Prof. A. W. Reinold, Prof. J. Emerson Reynolds, Dr. R. H. Scott, Prof. C. S. Sherrington, Mr. J. J. H. Teall, Sir J. Wolfe Barry, K.C.B.

In the evening the Fellows and their friends dined together at the Whitehall Rooms.

NOTES.

DR. E. VON MOJSISOVICS, Vice-director of the Austrian Geological Survey, has obtained permission to retire from the active staff of the service on account of the state of his health. But his scientific labours will suffer no interruption. In particular he will be able to continue, and, it may be expected, bring to an early completion, two important works on which he is engaged —"The Cephalopoda of the Halstatt Limestone," and "The Geology of the Salzkammergut."

PROF. J. PERRY, F.R.S., presided at the annual dinner of the Institution of Electrical Engineers on Monday, and in responding to the toast of the Institution he compared the profession of electrical engineering with a baby, inasmuch as the members were ignorant of its future, though they knew that its life would be affected by the action adopted now. Other speakers were Lord Alverstone, Lord Kelvin, Sir J. Wolfe Barry, Sir G. Kitson, and Sir Courtenay Boyle, who spoke as the representative of a department (the Board of Trade) which has to do with the translation of scientific researches into commercial facts.

MR. I. H. BURKILL, of the Royal Botanic Gardens, Kew, has been appointed assistant to Dr. Watt, and will shortly leave for Calcutta.

WE learn from the *Athenaeum* that an official announcement has been made to the effect that the Viennese Akademie der Wissenschaften intends sending an expedition to Brazil in 1901, which will have for its object the study of the flora of that country. It is to a certain extent a sequel of the expeditions of the early part of this century, which resulted in the publication of that monumental work the "Flora Brasiliens." The botanists accompanying the party are Prof. Dr. Richard von Wettstein, Director of the botanical garden of the University, and Dr. Victor Schiffner of Prague.

IT is announced by the Colonial Office that the Pacific Cable Committee have accepted, on behalf of her Majesty's Government and of the Governments of New South Wales, Victoria, Queensland and New Zealand, the tender of the Telegraph Construction and Maintenance Company for the manufacture and laying of the projected Pacific cable. The amount of the tender is 1,795,000*l*., and the work is to be completed by the end of 1902. The cable will run from Vancouver to Queensland and New Zealand, *via* Fanning Island, Fiji and Norfolk Island.

A FEW particulars concerning the Antarctic expedition in course of organisation in Sweden, by Dr. Otto Nordenskjöld, are given in the *Times*. For the purpose of his Antarctic expedition Dr. Nordenskjöld has acquired the steam-whaler the *Antarctic*, which was built for whaling in the Greenland seas by a Norwegian firm, and has performed many voyages in Polar waters. She was eventually acquired by Prof. G. Nathorst, the celebrated geologist and Arctic traveller, who has shared in almost every Swedish Polar expedition. Last year, again, the *Antarctic* was employed in the search for Andrée on the east coast of Greenland, when the owner himself was in command of the expedition, but which yielded no result. The vessel will proceed to Gothenburg for her final equipment. Dr. Nordenskjöld estimates the cost of the expedition at only some 10,000*l*. Of this sum one-half has already been contributed by Swedish subscribers, and King Oscar, with his well-known interest in Swedish explorations, has also promised a considerable amount towards this expedition, the first of its kind ever dispatched from Sweden. Should circumstances permit, the Swedish expedition will, of course, co-operate with the British and German. It is hoped that the *Antarctic* will be ready to sail next August.

THE Lincolnshire Naturalists' Union has recently received several valuable additions to its museum. Further space is required for a large collection of fossils and specimens of rock formation recently presented by Mr. Melville. A large case of drawers containing a number of birds' skins from the collection of the late president of the Union (Mr. John Cordeaux) has been presented by Mrs. Cordeaux. A large collection of fossils and specimens of rock formation has been presented by Mr. A. S. Leslie-Melville. The collections would make a good nucleus for a county museum, and the City Council of Lincoln is to be asked to make suitable provision for them.

IT is satisfactory to know that British engineers and manufacturers are seriously examining the causes which have enabled German and American works to successfully compete with their productions. Sir Lowthian Bell dealt with the subject in his address to the Institution of Junior Engineers on November 30. In the course of his remarks he said: "Some correspondents of our newspapers attributed our loss of ground in the race to ignorance of the scientific truths on which success was dependent; but they could not be aware that at Newcastle, Leeds, Nottingham, Sheffield, Edinburgh and Glasgow there were large and well-appointed colleges for teaching the sciences which for the last twenty-five years had been deemed indispensable in Great Britain for a successful career in metallurgy. Moreover, every ironworks of any importance possessed a suitable laboratory as a guide in its daily operations as well as for original research. Comparison between the United States and England involved two conditions—that imposed by nature, and that resulting from ignorance and consequent want of skill; the former was unavoidable, the other susceptible of remedy. Now, taking the Middlesbrough district in this country and Pittsburg and its vicinity in America, it appeared that the final cost of the minerals, mining and carriage included, consumed for each ton of pig iron at Pittsburg and Middlesbrough was almost identical." Though Sir Lowthian Bell's estimate of the alleged advantages of the Pittsburg works may do something to reassure British manufacturers, his remarks as to educational facilities and industrial research are not so convincing. True, we have our University Colleges and Technical Schools, but in how many districts are they considered by the manufacturers to have

any real connection with industrial progress? When the business man really believes in such institutions, he does not regard them merely as places where a smattering of useful knowledge can be obtained, but as laboratories where adequate provision has to be made for scientific research. As for the laboratories provided for investigation in ironworks and other manufactories, they are as nothing in comparison with what they ought to be. When they do exist, they are often regarded as failures unless every year the cost of their upkeep is less than the saving they effect. What British manufacturers mostly lack is belief in scientific results and sympathy with the scientific spirit. So long as they are deficient in these qualities, they will be unable to derive the fullest advantage from scientific progress.

MR. FOX BOURNE, on behalf of the committee of the Aborigines Protection Society, has addressed a letter to Mr. Chamberlain with reference to the condition of aborigines of Australia. It is submitted that a comprehensive and uniform native policy should be adopted for the whole of Australia, with harmony and equal efficiency in the measures taken for carrying it out. After referring to the importation of Kanaka and other native labour, the letter recognises that arbitrary interference by her Majesty's Goverment would be inexpedient and impracticable, but urges that the Governor-General and his advisers should be communicated with on this subject, in the hope that they will see their way to take such measures as will ensure to the aborigines adequate protection.

MR. A. B. BASSET asked, in our issue of October 11 (p. 572), for a word to designate a non-singular curve, and suggested that a curve having no double points might be termed an "anautotomic curve." Other correspondents have thought that the idea of curves without double points could be conveyed by the words nonsesecting, (p. 7), unautotomic, and nodeless (p. 58). There is an objection to such hybrid terms as "unautotomic," but Mr. W. R. K. Watson writes to point out that "nodeless" stands on different grounds, because the rule against combining elements derived from different languages does not apply to the terminations. Mr. T. B. Sprague also sends us a letter in which he expresses the view that nodeless is a suitable word. Hence, if anautotomic is objected to on the score of euphony, the balance of opinion appears to be in favour of nodeless.

AT a recent meeting of the West Riding section of the Society of Dyers and Colourists, Messrs. A. Dufton and W. M. Gardner read a paper on their arrangement for the production of an artificial light of the same quality as daylight, and illustrated its practical value. The lamp devised for this purpose was shown at the Bradford meeting of the British Association, and has already been briefly described (vol. lxii. p. 563, October 4).

IN *La Nature* of November 24, M. E. Durand-Gréville gives a good description and illustrations of the so-called Pocky or festoon cloud. It was probably first observed by Lamarck about a century ago, and was subsequently frequently seen in the Orkneys, and referred to in pamphlets entitled "Popular weather prognostics of Scotland," by Sir A. Mitchell in 1863, and by the Rev. Dr. Clouston in 1867. It has the appearance of a *cumulus* cloud reversed, or as it would be seen from a balloon, and it was named by the recent International Cloud Committee *mammato-cumulus*. It was supposed to be formed of drops of water, and its occurrence was in most cases followed by storms either of rain or wind. M. Durand's observations lead him to suppose that it is by no means always composed of water-drops, but that it is often formed of small needles of ice. He proposes that this name should be maintained when it is certain that it is composed of water-drops, but to employ the term *mammato-cirrus*, or Poey's *globo-cirrus*, when it is equally clear that the cloud is ormed of ice-crystals.

A REPORT on the acetylene flame, considered with especial reference to its use in physical laboratories, is given by Mr. Edward L. Nichols in the *Journal* of the Franklin Institute. The report deals with the following points: The falling off in illuminating power when the acetylene is stored for some time, especially over water; the influence of the pressure and mode of production; the characteristics of pure acetylene flames; the temperature of the flame; and the uses of acetylene for the lantern, for the production of high temperatures, and for photometric measurements. A further report on the efficiency of the acetylene flame as a source of light is contributed by the same writer to the *Physical Review* (October).

PROF. KLEIN announces that the publication of Gauss's works, which has been delayed since the appearance of the sixth volume, will be resumed under the editorship of Prof. Brendel, who will have the collaboration of Profs. Fricke, Stäckel, Börsch, Krüger and Wiechert. Volume viii. has already appeared, and contains a miscellaneous collection of hitherto unpublished writings on arithmetic, algebra, analysis, probability and geometry. Volume vii. will contain the *Theoria motus*, as well as a complete collection of Gauss's works on astronomical perturbations; volume viii. will deal with Gauss's geodetic operations and certain physical problems, supplementary to those treated in previous volumes; and volume x. will consist of biographical matter, including extracts from Gauss's correspondence.

A DETAILED account of the system of multiplex telegraphy, which has for its basis the use of alternating currents of different frequencies, is given in the *Journal de Physique* for November by M. E. Mercadier.

IN the *Journal de Physique* for November, M. Raphael Dubois describes in a short note some experiments on the use of photobacteria as sources of illumination. By cultures on a large scale, with liquid nutrient media, the author states that it has been possible to illuminate a room with the brilliancy of moonlight.

A COPY of a very rare botanical pamphlet—the "Orbis Eruditi Judicium de Caroli Linnæi, M.D. Scriptis," dated, Holmiæ, 1741, is offered for sale in a German book circular (*Recensions-exemplar*), at the moderate price of 120 marks. This is the only "apology" ever written by "Linnæus, and the only work published by him anonymously. It is especially directed against his bitter antagonist, J. G. Wallerius, the mineralogist. Pritzel, by whom this work was not mentioned in the first edition of his catalogue, states in the second edition that he saw a copy in the library of de Candolle. Besides this only three other copies appear to be known, two of which were offered for sale at an auction in Stockholm in November, 1888. The pamphlet contains a *résumé* of the most important events in the life of Linnæus, as well as a list of his works to date.

IN his presidential address to the twelfth annual meeting of the Association of Economic Entomologists, held in New York last June, Mr. C. P. Gillette urged the importance of the study of the life-histories of insects injurious to crops, saying that much remains to be learned, even in the case of the commonest and most abundant species. The *Proceedings* of the Association are published as a *Bulletin* (No. 26) by the Entomological Division of the U.S. Department of Agriculture. Among the numerous papers, one of the most interesting deals with the methods adopted for the destruction of the green-pea louse, the illustrations showing the extensive scale on which the operations are conducted. The Association, which is stated to be the only one of its kind in existence, comprises 109 members resident in the United States and 42 foreign members.

WE have received a copy of the *Communications* of the Millport marine biological station for November. Among the more important contents are a paper by Miss Newbigin on the

sabellid worms collectively designated as Polychætes, one by Mr. A. Patience on the Decapod Crustacea of the Largs Channel, and one by Mr. J. Rankin on the Tunicates of the Millport neighbourhood, the latter containing descriptions of three new species. Attention may also be directed to a communication by Dr. J. F. Gemmill regarding the influence of nutrition on sex. The mussel and the limpet, in which the differentiation of sex does not take place till a comparatively advanced stage of life, are taken as examples; and it is shown that the more highly nourished individuals living in low zones do not display any preponderance of females over their less fortunate brethren, who are out of water for a longer period at each tide.

PART ii. of vol. xxix. of the *Morphologisches Jahrbuch* is chiefly taken up by investigations on myology, one of these papers, by Herr H. Engert, dealing with the development of the abdominal muscles of birds, while the second, by Herr H. Klaatsch, treats of the short head of the *biceps cruris* (or *femoris*) and the so-called *gracilissimus* muscle of the thigh in mammals. As its subtitle—ein stammesgeschichtlicher Problem—implies, the latter is really a phylogenetic paper, taking into consideration the relations of man to the other Primates, and of the latter to other mammalian orders. To formulate the author's investigations and conclusions briefly is by no means easy. But it may be mentioned that he identifies the *gracilissimus* (which must not be confused with the *gracilis*) with the short head of the *biceps cruris* of human anatomy, and finds that the lower Old World monkeys possess no representative of this muscle at all. For this muscle, in its different forms, the name *gluteo-cruralis* is proposed. It occurs as a true *gracilissimus* in the lower American monkeys, all Carnivora, and certain Rodents, Marsupials, Edentates and Insectivora. As the main muscle of the upper leg it is found in some Edentates, the Orang, and the majority of the American monkeys, while it forms the short head of the *biceps cruris* in man, Gibbons, the Howlers, the Chimpanzee and the Gorilla. Whether the Old World monkeys have lost the *gracilissimus*, or whether they never possessed that muscle, is left an open question. But it is urged that the less a monkey departs from the primitive type (as represented by the Carnivora), the nearer it approaches man, and in this respect the majority of American monkeys are more man-like than their Old World representatives.

To the *Zeitschrift fur wissenschaftliche Zoologie* (vol. xviii., pt. 3), Herr C. Sihler contributes a paper on muscle-nerves, while in the same issue Herr R. Hesse continues his investigations on the visual organs of the lower animals, dealing in this instance with the eyes of certain molluscs.

MR. THOMAS SHEPPARD has prepared a descriptive catalogue of the specimens in the Mortimer Museum of Archæology and Geology at Driffield. The specimens were gathered together by Mr. J. R. Mortimer during the past forty years, and they comprise relics of Neolithic and later periods which are described, explained and in many cases illustrated in the work before us. Some doubtful Palæolithic and Eolithic flints are mentioned. Mr. Mortimer began collecting at a time when the Yorkshire Wolds formed a region prolific in pre-historic remains. The farm labourers were induced to spend their spare time in searching for them, and many a basketful of specimens was brought to Mr. Mortimer. Now these treasures are rare. Fossils from the chalk were also more readily to be obtained in former years, when the chalk was more extensively quarried, and a fine series of fossils from this and other local strata is exhibited in the museum. The handbook now issued will be of essential service to local workers.

FURTHER illustrations are presented by Mr. W. J. G. Land, in a short article reprinted from the *Botanical Gazette*, of the remarkable process in the fertilisation of flowering plants observed by Nawaschin, Guignard, Miss Sargant, and others. These observations explain the invariable presence of two sperm-nuclei in the pollen-tube by the fact that, while one of them fuses with the oosphere to produce the embryo, the other fuses with one of the polar nuclei of the embryo-sac (or with both when combined into the central nucleus) to produce the endosperm. Mr. Land adds to the Angiosperms in which this process has been observed two genera of Compositæ, *Erigeron* and *Silphium*. He does not accept Guignard's designation of the process "pseudo-fecundation," but regards it as a true process of impregnation. It is interesting, also, to note that in these genera the sperm-nuclei of the pollen-tube have, as in other instances, the coiled form, which indicates their descent from the spermatozoids of vascular cryptogams.

THE *Agricultural Gazette* of New South Wales contains an article by Mr. W. J. Allen on the culture of the olive in Australia. He states that in both South Australia and Victoria this industry has received considerable attention, good crops of fruit being now obtained which yield a good oil. It is evident, however, that if, as Mr. Allen says, the climate of every part of New South Wales is suitable for the growth of the olive, it may in the future become a much more important industry in our Australian colonies than it is at present.

THE December number of the *Journal* of the Chemical Society contains a portrait of the late Prof. Nilson, and the Nilson memorial lecture delivered by Prof. O. Pettersson.

MESSRS. BLACKIE AND SON have published the seventh edition of "An Elementary Text-book of Coal Mining," by Mr. Robert Peel. A chapter has been added on the applications of electricity to various operations in mining.

MR. A. M. BRICE gives a graphic account of the great Charleston earthquake of 1886, in the December number of *Macmillan's Magazine*. In many respects it resembles Mr. McKinley's equally vivid account quoted in Captain Dutton's memoir. The panic of the whites, the childish terror of the negroes, the destruction of the city and many other features are well described. Mr. Brice also gives some interesting examples of the apparently capricious effects of the earthquake, some houses being comparatively unhurt and yet standing in the midst of others completely ruined.

THE *Transactions* of the Rochdale Literary and Scientific Society contain papers on various subjects read before that Society. In vol. vi. (1898–1900), among the articles of general scientific interest are a list of the birds that frequent Hollingworth Lake, by Mr. J. Stott, and a description of Hades Hill Barrow, by Mr. W. H. Sutcliffe. This is a round barrow and contained a broken rude urn, some burnt bones and flint implements and flakes.

IN NATURE (vol. liv. pp. 449–450), an account is given of the sea-waves connected with the Japanese earthquake of June 15, 1896, so far as they affected the eastern coasts of the islands. The propagation of the sea-waves across the Pacific is discussed by Dr. C. Davison in the last number of the *Philosophical Magazine*. Copies of the records of the tide-gauges at Honolulu and Sausalito (San Francisco Bay) are given. The earthquake originated beneath an area near the foot of the western slope of the Tuscarora Deep, and the sea-waves traversed the distances from the epicentre to Honolulu and Sausalito, which are 3591 and 4787 miles, in 7h. 44m. and 10h. 34m. respectively. The path from the epicentre to Sausalito is free from islands, and the mean depth along it is roughly 17,000 feet. If the depth were uniform, that corresponding to the mean velocity with which the waves travelled would be 13,778 feet. The explanation of the

discrepancy is given by the same writer in a former paper (*Phil. Mag.* for January 1897), in which it is shown that the formula generally used for determining the mean depth of the ocean is incorrectly applied.

An interesting account of an old Indian settlement in Kansas is given by Mr. J. A. Udden in the second number of the Augustana Library Publications, Ill. The paper is well illustrated by a number of excellent figures, and it gives an instructive view of the culture of a frontier village, which exhibits a mingling of northern, southern and western features of primitive industry and art.

In a short essay on Tabu in *l'Anthropologie* (Tome xi., p. 401), M. Salomon Reinach points out that the primitive idea of Tabu is more restricted than mere prohibition. It has three characteristics: (1) no reason is assigned, but reasons are added later; (2) the punishment, whether of death or sickness, results automatically from the infringement. Neither a deity nor man, individual or collective, is credited with avenging power; (3) the danger is not apparent. The power of Tabu has been broken by various religions, who have in their turn at times been sad enemies to human liberty.

Naturalists and others interested in bird life will be pleased to learn that arrangements have been made for the speedy resumption of the publication of Mr. W. Eagle Clarke's work on the birds of Yorkshire, which has been partly published in the *Transactions* of the Yorkshire Naturalists' Union, and the continuation of which was interrupted by Mr. Clarke's leaving Yorkshire to settle in Edinburgh. Mr. Thos. H. Nelson, of Redcar, will continue and complete the work. He has now in his possession the original and unpublished observations which Mr. Clarke had at his command when writing the instalments which are already in print, and which include notes, lists and observations from most of the naturalists who have studied and observed Yorkshire birds. In addition to this is the whole of the information amassed by the late Mr. John Cordeaux relating to the birds of the Humber district, and also the notes which Mr. W. Denison Roebuck has extracted from the very voluminous literature of the subject, and Mr. Nelson's own accumulated series of notes on the birds of Cleveland and other districts, the whole forming an ample mass of material for the purpose.

Mr. Walter W. Froggatt, the Government entomologist of New South Wales, has lately published a series of rather important papers, chiefly as "Miscellaneous Publications" of the Department of Agriculture at Sydney. Among those issued during the present year are No. 358, "Notes on Australian Coccidæ (Scale Insects)"; No. 363, "Plague Locusts"; No. 363, "The Hessian Fly (*Cecidomyia destructor*, Say) and allied Grain Pests"; No. 387, "Insects and Birds"; No. 388, "Insects living in Figs, with some account of Caprification." Other papers by Mr. Froggatt before us are "Miscellaneous Publication," No. 394, "Notes on a Collection of Ticks, determined by Prof. Neumann," from the *Agricultural Gazette* of N. S. Wales; "Scale Insects that produce Lac, with a description of a new Australian Species"; apparently an independently issued pamphlet; and "Australian Psyllidæ," from the *Proceedings* of the Linnean Society of New South Wales, for May. The last paper is illustrated with four plates, and most of the others with one each.

The question of the possible variability of the valency of carbon has received a considerable amount of attention, especially since the researches of Nef on divalent carbon. In the current number of the *Berichte* there is a somewhat startling extension of this idea by Mr. M. Gomberg. By the action of metals such as silver, zinc and mercury upon triphenyl-chlormethane, $(C_6H_5)_3CCl$, the halogen is removed, and, working in the complete absence of air, the resulting product is not as would be expected hexaphenyl-ethane, but an unsaturated body which readily absorbs oxygen from the air and combines directly with the halogens. The author thinks that the only possible explanation of the observed facts lies in the assumption that the substance is really triphenyl-methyl, $(C_6H_5)_3C$, in which the carbon is trivalent. Further work on this subject will be awaited with interest.

The additions to the Zoological Society's Gardens during the past week include a Suricate (*Suricata tetradactyla*) from South Africa, presented by Captain J. C. Brinton; a Raven (*Corvus corax*), British, presented by Mr. J. C. Brush; four Ashy-crowned Finch Larks (*Pyrrhulauda grisea*), two Singing Bush Larks (*Mirafra cantillans*), two Slaty-headed Parrakeets (*Palaeornis schisticeps*), a Golden-eyed Fruit Pigeon (*Carpophaga concinna*) from British India, a Burmese Slaty-headed Parrakeet (*Palaeornis finchi*) from Burmah, presented by Mr. E. W. Harper; a Doguera Baboon (*Cynocephalus doguera*, ♂) from Abyssinia, a Salvin's Amazon (*Chrysotis salvini*) from South America, three Alligator Terrapins (*Chelydra serpentina*), two Sculptured Terrapins (*Clemmys insculpta*), three Blue Lizards (*Gerrhonotus caeruleus*), two King Snakes (*Coronella getulus*), a Three-striped Boa (*Lichanura trivigata*), six American Box Tortoises (*Cistudo carolina*) from North America, twenty Climbing Anabas (*Anabas scandens*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

Perturbations of Eros Produced by Mars.—H. N. Russell has recently published the results of an extensive investigation of the perturbations of the major axis of the orbit of Eros by the action of Mars in the *Astronomical Journal* (vol. xxi. No. 484). As the periods of the two planets are nearly equal and their orbits interlock, the disturbing force will in consequence vary greatly in magnitude, and may have any direction whatever. Also, as Eros is sometimes nearer the sun than Mars, and sometimes more remote, the development of the perturbative function proceeding by powers of the ratio of their radii vectores gives rise to a *divergent* series; and as the magnitude of the eccentricities and inclinations makes development in ascending powers of these quantities undesirable, methods based upon mechanical quadrature are preferable.

The present investigation has been by means of Le Verrier's method of interpolation, and its relative merits and disadvantages are discussed. Newcomb's Elements of Mars have been used, those of Eros being original computations published in the *Astronomical Journal* (No. 473).

The numerical results obtained are given in a table, the chief results being:—

(1) The "great inequality," of period about 1000 years, will not affect the place of Eros sensibly during the next dozen years.

(2) The perturbations of moderately long period are much the largest produced by Mars on any planet. They may displace Eros by as much as 90″ in mean longitude; and since at a perihelion-opposition any change in the mean longitude of Eros produces one *ten* times as great in its geocentric longitude, the measurement of this displacement will eventually lead to a valuable determination of the mass of Mars.

Catalogue of One Hundred New Double Stars.—Prof. W. J. Hussey, of the Lick Observatory, has completed observations of another hundred new pairs in continuation of those in his first catalogue, published in the *Astronomical Journal* (No. 480), and gives the details of the recent measures in No. 485. The work has been done with the 12- and 36-inch equatorials, chiefly with the latter, using generally a power of 1000. An analysis of the distances between the components leads to the following summary:—

Distance.	No. of Pairs.
0″·25 or less	9
0″·26 to 0″·50	16
0″·51 to 1″·00	22
1″·01 to 2″·00	26
2″·01 to 5″·00	27

OSCILLOGRAPHS.

THE phenomena connected with the behaviour of alternating currents present a wide field for experimental inquiry which has, up to the present, been but imperfectly explored. The investigation of the wave-forms of alternating potential differences and currents under various conditions of their actual use is a matter, not only of great theoretical and scientific interest, but also of the highest practical importance, since the shape of the wave-form under given conditions, and the alteration of shape produced by any alteration of conditions, are factors which largely affect the efficiency and economy of working. As examples showing the increased efficiency that may be obtained by choosing a suitable wave-form, we may quote the results obtained by Messrs. Rössler and Wedding, and by Messrs. Barr, Beeton and Taylor. The former experimenters showed,[1] in an investigation on the luminous efficiency of the alternate current arc, that the light per watt when using an alternator giving a flat-topped E.M.F. curve was 44 per cent. higher than when using a machine that gave a peaked curve. Messrs. Barr, Beeton and Taylor, in a research on the efficiency of transformers, found,[2] on the contrary, that a peaked wave-form was the most suitable one to employ. The reactions that take place between alternators running in parallel is another case in which the wave-form is of very great practical importance.

It will be readily understood, therefore, that it is most desirable that we should have some simple method of observing and studying the wave-form of an alternating current or potential difference. Such a method is supplied by the instruments known as oscillographs. Before the invention of these instruments the only means of studying wave-forms was by the exceedingly laborious "point-to-point" method. Suppose that there is a circuit through which is flowing an electric current which is varying periodically at the rate of, say, n, complete cycles per second, and that it is desired to obtain the wave-form of this current. At any particular instant the current will have a certain definite magnitude and direction, and $1/n$th of a second later the current will again have the same magnitude and direction. If, by means of an automatic contact-maker, a galvanometer is brought into circuit at intervals of $1/n$th of a second, there will be given to the galvanometer needle a succession of impulses due, in each case, to the same current, and consequently a steady deflection of the needle will be produced from which the particular instantaneous value of the current can be determined. To obtain, however, the complete wave-form, we must determine the value of the instantaneous current at *every moment* during the cycle, or at a sufficient number of moments to enable a smooth curve to be drawn. Having found one point on the wave-form in the way described, the contact-maker is shifted so as to bring the galvanometer periodically into circuit at some other moment in the cycle, and a second point on the curve is then found. Again the contact-maker is shifted and a third point is obtained, and thus, point by point, the whole curve may be built up.

This method is open to two objections. In the first place, it is only applicable to cases in which the wave-form is undoubtedly steady, all transient effects being obviously unobservable by such a process, and, secondly, it is so lengthy that elaborate researches are practically precluded. As much as four or five hours may, indeed, be spent in obtaining a single curve, and then, even after all this labour, it is more than possible that the conditions will be found to have altered during the experiment, and the curve, in consequence, to be useless. By means of the oscillograph and kindred instruments, however, experiments can now be carried out in a few minutes which occupied days by the old "point-to-point" method, and not only can steady wave-forms be examined, but the most fleeting effects can be studied with equal ease.

An oscillograph may be defined as a galvanometer the deflection of which, at any instant, is practically proportional to the current flowing through it at that instant, in spite of the current varying very rapidly in strength or in direction. For this to be possible it is necessary for the free periodic time of the moving part of the instrument to be very short, less, generally, than 1/30th, of the periodic time of the effect to be observed. The instrument must also be perfectly dead-beat, the moving part taking up instantaneously the deflection proper to the current flowing through the instrument, for if there be any tendency to overshoot the mark it will cause the observed wave-form to be distorted from its true shape. In addition to this, since one is dealing with rapidly varying currents, it is necessary for the self-induction of the instrument to be practically nil, and for all effects due to hysteresis or eddy-currents to be eliminated. The original idea of the oscillograph is due to M. Blondel, who pointed out, in 1893, the principles on which such an instrument should be designed, and all the oscillographs since produced owe their inspiration to M. Blondel's work.

Two other instruments have been invented and developed by which the same end might be attained, namely, the observation or recording of rapidly varying currents or potential differences. These are the Abraham-Carpentier rheograph and the Hess-Braun oscillo-radiograph. With these instruments, since they are not, strictly speaking, oscillographs, we do not propose to deal in detail, but must content ourselves by giving a brief account of the principles on which they are constructed. In the rheograph, instead of making the free periodic time of the instrument excessively small, M. Abraham uses a galvanometer with a period of about 1/10th of a second, and attempts to compensate errors due to the inertia of the moving part by utilising the effects of electromagnetic induction. With this instrument M. Abraham, it is said, has been able to study oscillating discharges having a period of about 1/10,000th of a second; but the adjustment is not an easy matter, and, moreover, has to be made every time the instrument is used. In the Hess-Braun oscillo-radiograph the difficulty of

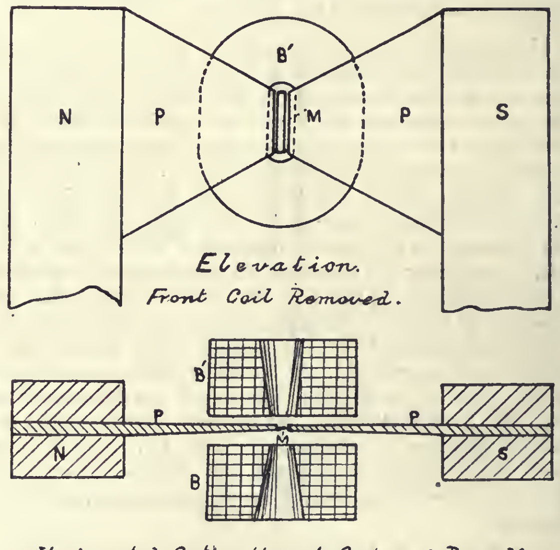


FIG. 1.—M. Blondel's oscillograph.

sufficiently reducing the inertia of the moving part is overcome in a very ingenious manner by using, as the galvanometer "needle," a beam of kathode rays in a vacuum tube. This beam is arranged to produce a bright spot on a fluorescent screen, and the movements of this spot are observed when the beam is deflected by the varying currents passing through two bobbins of wire on either side of the vacuum tube. Unfortunately these bobbins, possessing self-induction, introduce errors. Another difficulty in this apparatus is to obtain good definition, and also sufficient intensity of illumination. On account of the small intensity it is only possible to use this instrument for the study of cyclic phenomena where, as the spot of light can be caused to travel over the same curve again and again, the curve can be observed or photographed.

Neither of these instruments has been brought to the same degree of perfection as the oscillograph, which has been developed into a very perfect instrument by M. Blondel in France and by Mr. Duddell in England. M. Blondel originally suggested three systems on which oscillographs might be constructed, in which the moving part consisted respectively of a small bar of soft iron, a vibrating plate of iron, and a light coil on a bifilar suspension. The instrument which M. Blondel first perfected, and with which his well known researches on the alternate current arc were carried out, was constructed on the first of these systems. The diagram (Fig. 1) shows the chief principles of its construc-

[1] *The Electrician*, 1894, vol. xxxiii.
[2] *Journal* of the Institution of Electrical Engineers, 1896, vol. xxv.

tion. A small bar of soft iron, M, to which is attached a light mirror, is pivoted between the pole-pieces, P.P., of a powerful magnet or electro-magnet. These pole-pieces are laminated and are specially shaped to give as strong a magnetic field in the air gap as possible. On each side of the pole-pieces is a coil of wire, B.B., through which the current to be observed flows. This current produces a field at right angles to that of the field magnet, and so deflects the iron bar through an angle which, if small, is proportional to the current. M. Blondel has produced an instrument of this type having a free periodic time of 1/6000th of a second; and, by replacing the small bar with an iron band stretched between the pole pieces, he has constructed an instrument having much smaller free periodic time than any other type of oscillograph—indeed as small as 1/50,000th of a second—but the sensibility at this high frequency is not very great. At a frequency of about 10,000 vibrations per second, its sensibility is about the same as that of the other types of instrument.

The credit of developing the bifilar oscillograph is due to Mr. Duddell, who, as the result of a long series of investigations

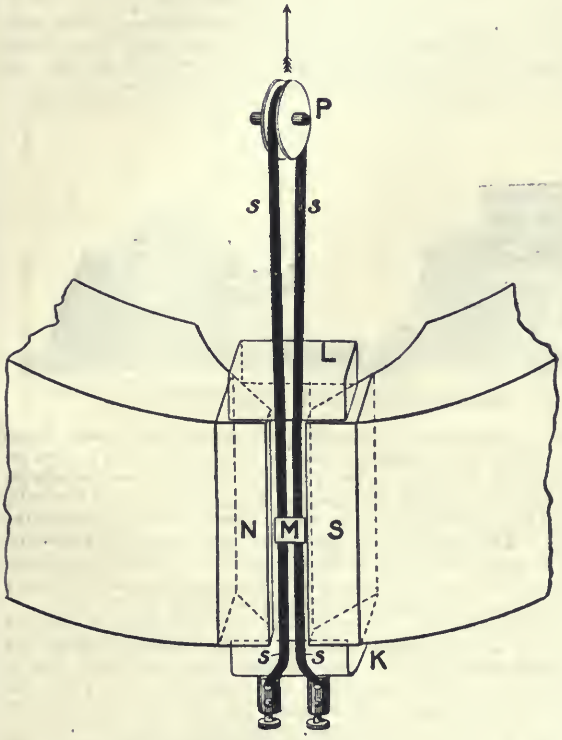


FIG. 2.—Mr. Duddell's oscillograph. (From the *Journal* of the Inst. Elect. Eng., vol. xxviii., 1899, p. 8.)

carried out at the Central Technical College, has produced instruments of this type possessing a high degree of perfection, and by means of their use has brought to light a number of new experimental facts. The principle of Mr. Duddell's oscillograph will be easily understood by reference to Fig. 2. The current to be observed flows up one side and down the other of the continuous strip of phosphor-bronze, *s.s.s.s.* This strip is looped over the pulley, P, which is attached to a small spring balance (see Fig. 3) by means of which the tension on the strip can be regulated. Each arm of the loop passes through the gap between the poles, N.S., of a powerful electro-magnet. The loop carries at its centre a mirror, M, which is made of a small piece of silvered cover-glass cemented to the strips. When a current passes through the loop, one side is moved forward and the other backward, and the mirror is thus deflected through an angle proportional to the current. The phosphor-bronze strips are held in position at the bottom by being clamped between ebonite insulating pieces at K, and at the top by being drawn against the single ebonite piece at L. It will be observed, therefore, that the only part of the strip that takes part in the vibration is that between K and L, and not, as might otherwise be supposed, the whole length from K to the pulley P.

By the use of phosphor-bronze, Mr. Duddell has found it possible to make very light strips having sufficient strength to enable considerable tension to be used, and having, at the same time, good conductivity. He has been able to bring down the free periodic time to 1/10,000th of a second, and, with a free periodic time as low as this, the mirror can easily follow, with extreme accuracy, the vibrations of an electric current alternating at the rate of 300 complete cycles per second, while even if the alternating current has a periodic time as short as 0·001 second, or even less, the record may possess sufficient accuracy for many purposes. The narrow gap through which the strips pass is only just large enough to allow of their free movement, and as the break in the magnetic circuit is consequently very small, the field can be made very intense. This space is filled with damping-oil, which is retained in it by a lens forming a front to the gap, and thus the strips are confined in a narrow oil-bath, in which they have only just room to move, the damping in consequence being very efficient and rendering the instrument accurately dead-beat.

Already the Cambridge Scientific Instrument Co. have constructed many specimens of two types of this form of oscillograph,

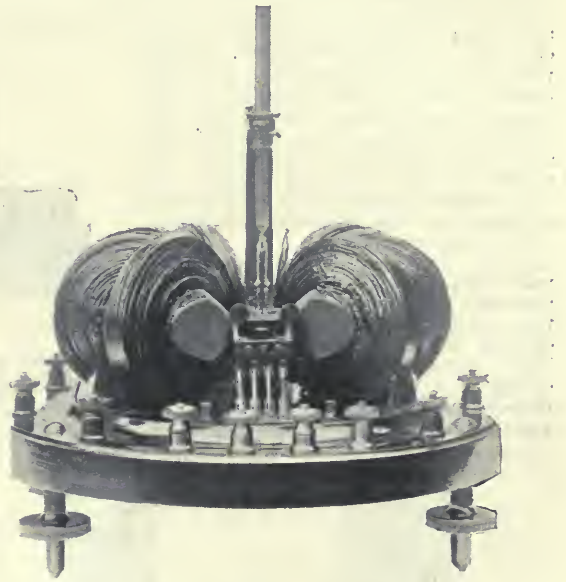


FIG. 3.—Mr. Duddell's oscillograph. High frequency pattern.

a large one for projection work and a high frequency instrument for more accurate research work. The general design in both types is the same, the chief difference lying in the high frequency pattern having its moving parts smaller and lighter, by which means the periodic time of 1/10,000th second has been obtained, whereas the free periodic time of the projection instrument is 1/2000th of a second. The instrument is made with two loops fixed side by side in the gap so that one may be used to give the wave-form of the current while the other is used to give the wave-form of the potential difference, the two curves being thus obtained simultaneously. There is a third fixed mirror between the two vibrating mirrors which is used to give a zero line. Small tangent screws enable the positions of the moving mirrors to be adjusted to zero. From Fig. 3, which is a photograph of the double instrument, a good idea of its general appearance and construction may be obtained. The light band between the poles of the magnet shows the position of the mirrors, but the illustration is on too small a scale for the mirrors themselves to be distinctly visible. This is not surprising when one considers that their actual size is only 1·0 mm. high by 0·3 mm. wide by about 0·1 mm. thick. The strips are connected through the four small upright fuses with the terminals on the front of the base of the instrument. The normal working current in the strips is 0·10 amp., and the sensibility at a scale distance

of 1000 mm. is nearly 600 mm. per ampere. The other terminals which are seen make connection with the magnet, on which there are four pairs of coils the ends of which are brought out to separate terminals so that the coils may be connected up

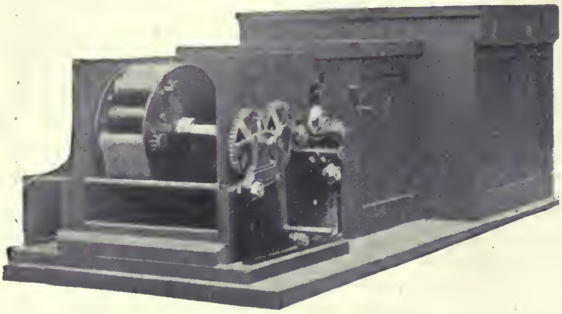


FIG. 4.—Photographic recording arrangement.

in series or parallel to suit the voltage obtainable. The magnet is wound so that the coils may be connected in series direct across 100 volt mains.

It is interesting to note that the oscillograph may be used to show the power curves, as well as the curves of current and potential difference. For this purpose it is only necessary to excite the electro-magnet by the alternating current, instead of from a direct current supply, when the instrument will act as a watt-meter, and give the power-curves. The accuracy is not so high when the oscillograph is used in this way; but the possibility of so using it is very advantageous, both for purposes of demonstration and research.

In order to observe the actual shape of the wave-form, it is necessary to introduce a movement of the beam of light reflected from the oscillograph mirror at right angles to the direction of vibration it already possesses. This may be done by observing the movements of the spot of light in a rotating mirror, or, if permanent records are desired, by receiving the spot on a moving photographic plate or film. This method may be used for observing or

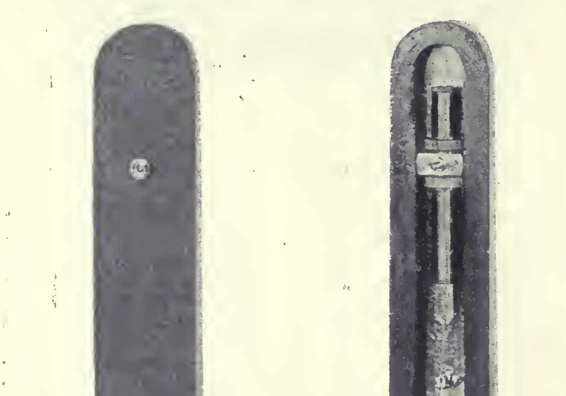


FIG. 6.—Mr. Duddell's portable pattern oscillograph.

recording any variations in current, whether they be periodic or not. In Fig. 4 is shown a photograph of the recording arrangement. The oscillograph is in the back part of the box, and in the front part may be seen the recording drum, which carries Kodak daylight changing spools. There is a shutter between the oscillograph and the film which enables any length of film up to 40 cm. to be used at each experiment, and this shutter carries a contact maker which can be used to start any non-periodic phenomena it may be desired to record. For the cases in which it is only periodic changes which have to be studied, Mr. Duddell has devised a very convenient arrangement in which the rotating mirror is replaced by one which is vibrated in synchronism with the waves of potential difference or current under observation. The mirror is vibrated by a small synchronous motor, and the spot of light is reflected from it on to a transparent screen above it; as the mirror moves with a uniformly increasing displacement the wave form is drawn on this screen, and when arrived at the full extent of its motion, the mirror is pressed back suddenly to its initial position, the beam of light being interrupted during this return journey by a shutter attached to the motor shaft. The mirror then starts on a fresh swing, and draws a second wave-form on the top of the first, the successive curves appearing, by persistence of vision, on the screen as a single bright line, which may be either traced, or photographed on sensitive paper. The size of the curves is about 3 cm. amplitude on each side of the zero and about 8 cm. in length, one and a half complete wave-forms being shown in this length. Fig 5 shows the synchronous motor in conjunction with the large oscillograph, the photograph illustrating the complete apparatus for projecting the curves on to a wall screen. On the right is the source of light, and the oscillograph is on the extreme

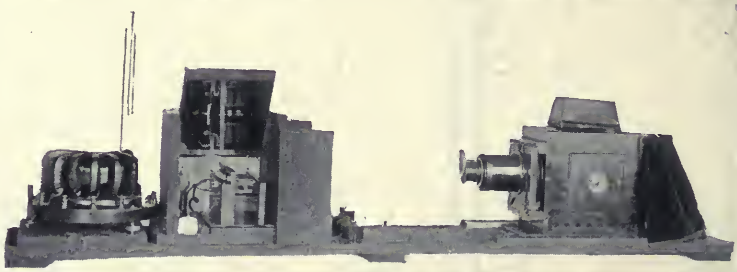


FIG. 5.—Arrangement of apparatus for projection work.

left; to the right of the oscillograph is the motor which drives the synchronous mirror, a view of the top of which is seen reflected in the glass above, this additional mirror being simply introduced to reflect the beam of light, which comes vertically from the synchronous mirror on the motor, horizontally on to the wall. The apparatus will give wave-forms having an amplitude of 50 cm. on either side of the zero and about 150 cm. long, showing in this length one and a half wave-lengths, and sufficiently bright to be seen by over two hundred people at one time.

Mr. Duddell has, we understand, just completed a portable form of oscillograph in which the electro-magnet is replaced by a permanent magnet. This instrument has only one loop of strip, so that it will only show one curve at a time; the free periodic time is 1/5000 of a second, and the sensibility at 1000 mm. scale distance is 750 mm. per ampere. Fig. 6 is a photograph of this small oscillograph, and shows the instrument with and without the front which protects all the working parts. The whole apparatus for observing wave-forms—oscillograph, source of light and rotating mirror—is fitted up ready for use in a small and easily portable box, and should prove of great value to central station engineers and others who employ alternating currents.

In Fig. 7 are shown some examples of curves of current and potential difference obtained by means of the oscillograph. These curves were photographed on to a falling plate, and are here reproduced half full size. Curve 1 shows the wave-forms of the P.D. between the terminals of a dynamo sending a current through an inductive and non-inductive resistance in series, and of the P.D. between the terminals of the non-inductive part, as well as the wave-form of the current flowing in the circuit. It will be seen that the self-induction has caused the current curve to be out of phase with the dynamo P.D., but there is no distortion of the shape. Curve 2 shows the characteristic wave-forms of the current and P.D. of an alternating current arc, burning between solid carbons. The P.D. has a high peak at the beginning, and the current curve lies flat along the zero line at the beginning and end of each half-wave. Curve 3 is for an arc burning between carbon

and zinc; these waves are particularly interesting, as it would be practically impossible to obtain them by the "point-to-point" method, since arcs between carbon and metals burn very unsteadily. The arc, it will be seen, only burns for half a period; when the metal is positive (upper curves) the current is able to flow, and the P.D. and current curves have the shape characteristic of the same curves for the carbon arc, only somewhat accentuated; for the other half period, when the metal is negative no current flows at all, and the current curve is flat along the zero line, the P.D. curve being, in consequence, that given by the dynamo on open circuit. The three curves are for a frequency of 100 periods per second. Curve 4 shows the P.D. and current through the primary of an induction coil in which the contact-maker was driven by a motor, no condenser being used. The steady growth of the current and its rapid fall at break can be clearly observed in the current curve. From the P.D. curve it will be seen that the P.D. at the start is high, since, until the current begins to flow, the P.D. between

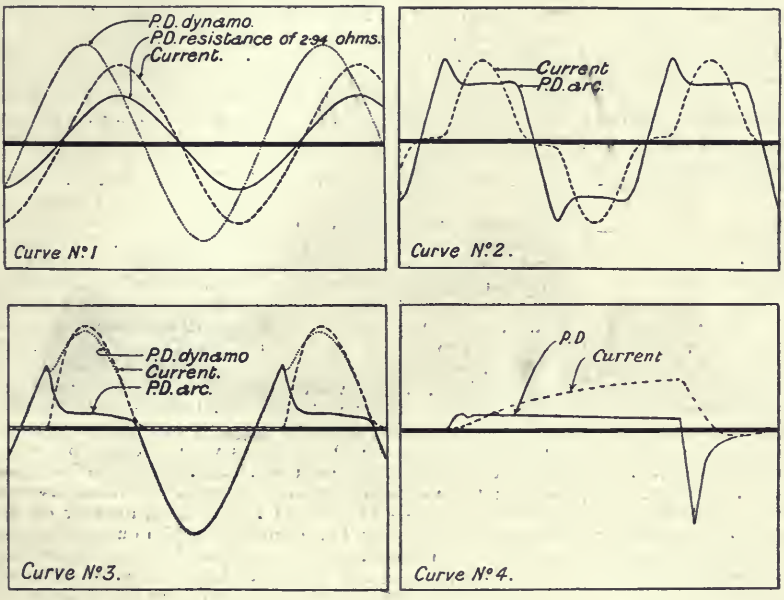


FIG. 7.

Data for Curves in Fig. 7.

No. of Curve.	Wave Forms for.	Periods per second.	Scale of P.D. Curve.	Scale of Current Curve.
1	Non-inductive Resistance.	100	1 mm. = 10 volts.	1 mm. = 2 amps.
2	Solid Carbon Arc.	100	1 mm. = 6 volts.	1 mm. = 2 amps.
3	Zinc-Carbon Arc.	100	1 mm. = 10 volts.	1 mm. = 2 amps.
4	Primary of an Induction Coil.	60 breaks	1 mm. = 2 volts.	1 mm. = 1 amp.

the terminals of the coil is equal to the E.M.F. of the cells. As the current rises, the P.D. between the terminals of the coil falls, due to the drop in volts in the circuit outside the coil; finally the break occurs and there is a large kick of the P.D. in the opposite direction to that applied.

From what has been said some idea will be gathered of the great value of the instrument that has been put into our hands by the invention of the oscillograph. To the scientific investigator it opens wide fields for experimental research, and it will enable the engineer to know more about the currents and E.M.F.'s with which he works. In addition, the projection oscillograph should prove invaluable for lecture and demonstration purposes, for even the simplest problems of alternate current working are by no means easy of comprehension by the average electrical student, who approaches them with only a bowing acquaintance with differential calculus and Fourier's theorem. The remarkable clearness with which their working can be demonstrated on the screen by the oscillograph will go a long way to give students a clear idea of their properties.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. T. Loveday, of Magdalen College, has been elected John Locke Scholar for the ensuing year.

Mr. G. C. Bourne has been re appointed a delegate for the extension of University teaching.

The electors to the Wykeham Professorship of Physics have appointed Mr. J. S. Townsend, Fellow of Trinity College, Cambridge, and Demonstrator in the Cavendish Laboratory.

CAMBRIDGE.—The Clerk Maxwell Scholarship in physics is vacant through the election of Mr. J. S. Townsend to a professorship at Oxford. Candidates are to apply to Prof. J. J. Thomson by December 18.

The British Westinghouse Electric Company have presented to the Engineering Laboratory a valuable dynamo and other apparatus illustrating the generation and use of polyphase currents.

AN opportunity for seeing the Northampton Institute, Clerkenwell, and examining some of the work done in the laboratories, will be afforded to-morrow evening (December 7), when the annual prize distribution and members' and students' conversazione will be held. Sir John A. Cockburn, K.C.M.G., will distribute the prizes.

IN an important article by Dr. William Wallace in the current number of the *Fortnightly Review*, on "the Scottish University crisis," attention is drawn to the urgent need there is for a greatly increased expenditure upon Scottish universities if they are to maintain the reputation they have enjoyed in times gone by. It is urged that a lump sum of not less than 1,500,000*l.* is required to place all the Scottish universities in such a position that their degrees should be regarded as of equal value with those of England, Germany, or even America. Such money is regarded as imperatively necessary for the following main purposes: (1) The conversion of the present skeleton faculties into real teaching organisations; (2) For laboratory and other scientific equipment; (3) For libraries; (4) For the endowment of industrial universities or of genuine industrial faculties in the universities; (5) For the endowment of poor undergraduates; (6) For the endowment of post-graduate research.

DR. OLIVER LODGE made some novel suggestions as to the time, place and purpose of University examinations, in his address to the students of the University of Birmingham on November 28. His proposals amount essentially to this—that examinations should not immediately follow teaching, and that a vacation interval should intervene for private study and revision, quiet thought, assimilation and digestion. Students should not be taken straight from a lecture-room into an examination-room, so that they might tell the examiner what the professor had said before they had time to forget it. So he wished to urge that a long vacation should be left between instruction and examination; that the examinations be held in September instead of at the end of June. If no interval for rumination was afforded during student days, if the unrooted ideas were pulled up for inspection by the examiner at the end of each session, and the student turned loose in the holidays, empty, swept and only partially garnished, for a period of complete idleness before another filling-in process began, then the last state of that man was liable to be little better than the first. The principle underlying Dr. Lodge's proposals is sound enough, but there are difficulties and objections in the application. What, for instance, is to prevent the student who wishes to obtain a good place in the examination at the commencement of the session

from devoting his holidays to study when he ought to be gaining physical strength and enjoying mental relaxation?

THE Emperor of Germany has given his consent to further reforms in the educational systems of the higher schools of Prussia, and a summary of the edict is given in the *Times*. The general education received in the three kinds of schools, the Gymnasium, the Realgymnasium and the Oberrealschule, is to be regarded as of the same value, and as only requiring to be supplemented in so far as for several branches of study and for several professions special preliminary knowledge is necessary which is not included in the curriculum of all three institutions. In accordance with this consideration, the desirability of extending the privileges of the Realgymnasien and the Oberrealschulen is to be kept in view. By this means it is hoped to raise these schools in public estimation, and to render an acquaintance with modern subjects more general. In view of the great importance of a knowledge of English, his Majesty lays stress upon the necessity of giving more attention to that subject in the Gymnasium. English is to be taught as an alternative subject to Greek in all the classes of those schools, except the three highest. Where the local conditions are favourable to the alteration, English is to take the place of French as a compulsory subject in the three highest classes. French, however, is to be retained as a voluntary subject wherever this change is made. The Emperor further regards it as advisable that more time should be given to geography in the higher Realschulen than has hitherto been the case. In the teaching of modern languages importance is to be attached to fluency in speaking and to the understanding of current authors.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, November.—The only paper in the present number is a note on geometry of four dimensions, by Prof. Lovett, which was read before this society on April 28 of this year. The writer indicates nine well-defined "trends" which the speculations relative to the geometry of n-dimensional space have followed, and directs his work to following up two out of these, viz., the interpretation of this geometry in the light of the theory of groups as exhibited by Lie, Klein and Poincaré and the extension of the methods of ordinary differential geometry to general spaces, *i.e.* as worked out by Christoffel, Beltrami, Cesàro, Darboux and others. This he does by constructing four dimensional space by the method of Lie's theory of continuous groups, and studying curves of triple curvature by the intrinsic analysis developed by Cesàro in his Lezioni di geometria intrinseca.—An account of the proceedings at the recent International Congress held at Paris is furnished by Miss C. A. Scott, in which she abstracts the addresses by Prof. Cantor, sur l'historiographie des mathématiques, and Prof. Volterra, trois analystes italiens, Betti, Brioschi, Casorati. Several of the papers communicated are lightly but clearly handled, and M. Poincaré's presidential address, du rôle de l'institution et de la logique en mathématiques, is concisely analysed. She plainly speaks her mind on many points of detail.—Dr. G. A. Miller gives an account of the 49th Annual Meeting of the American Association for the Advancement of Science so far as it relates to the work of the society. The meeting was held at Columbia University, June 23—30, and from the point of view of scientific work it is said to have been one of the most successful that has been held by the association. About twenty papers were read in section A., some of which are given in brief abstract.—In the "notes" additional particulars (to those given in the October number) are given of the mathematical courses to be followed in the coming winter at British and Continental colleges.—Personal details as to deaths and new appointments, with the usual "new publications," close the number.

IN a paper on new and critical British Algæ, in the *Journal of Botany* for October, Mr. E. A. L. Batters describes no less than three new genera of sea-weeds:—Neevea, belonging to the Bangiaceæ, represented by *N. repens*, endozoic on *Flustra foliacea* at Deal; Rhodophysema (Florideæ), founded on *R. Georgii*, growing on *Zostera marina* off the Scilly Islands; and Erythrodermis (Florideæ), represented by *E. Alleni*, dredged up from 4—6 fathom water at Plymouth.—In the number for November Mr. Pearson describes and figures a new liverwort, *Lejeunea Macvicari*, from Inverness-shire; and Mr. E. S. Salmon a new parasitic fungus belonging to the Erysipheæ, *Uncinula septata*, from Japan.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 15.—"Data for the Problem of Evolution in Man. VI.—A First Study of the Correlation of the Human Skull," by Alice Lee, D.Sc., with some assistance from Karl Pearson, F.R.S., University College, London.

November 22.—"On the Restoration of Co-ordinated Movements after Nerve Crossing, with Interchange of Function of the Cerebral Cortical Centres." By Robert Kennedy, M.A., D.Sc., M.D.

Zoological Society, November 20.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. Sclater stated that during a recent short stay at Gibraltar he had visited the haunts of the Barbary Ape (*Macacus innuus*), at the top of the Rock, and had ascertained that the herd of these animals was in a flourishing condition, and had considerably increased during the last few years.—An extract was read from a letter from Sir Harry Johnston, K.C.B., containing indications of a supposed new species of the Horse-family (Equidæ) which appeared to inhabit the Great Congo Forest, near the Semliki River, East Africa.—Mr. G. A. Boulenger, F.R.S., exhibited and made remarks on one of the type-specimens of a new species of Protopterus from the Congo, for which he had proposed the name of *Protopterus dolloi*.—Dr. W. T. Blanford, F.R.S., exhibited and made remarks upon a very fine pair of horns and some skins of the Central-Asiatic Wapiti, lent to him for examination by Mr. Rowland Ward.—Mr. F. E. Beddard, F.R.S., read a paper on the Osteology of the Pigmy Whale (*Neobalaena marginata*), based mainly on an examination of one of the specimens of this animal in the British Museum. A detailed description of the skeleton was given, and the features in which it differed from that of other known forms of the Cetaceans were pointed out.—Prof. Howes, on behalf of Prof. Baldwin Spencer, F.R.S., gave a description of *Wynyardia bassiana*, a fossil Marsupial from the Tertiary Beds of Table Cape, Tasmania. It was remarkable as being the first fossil Marsupial obtained from the Tertiaries of Australia, and appeared to be a Polyprotodont, having affinities with the Didelphyid, Dasyurid, and Phalangistid series, which had probably struck off from the rootstock at the period at which the Diprotodonts were in course of evolution.—A communication from Mr. L. A. Borradaile contained an account of a collection of Arthrostracans and Barnacles from the South Pacific.—Mr. Oldfield Thomas read a paper on the Mammals obtained by Dr. Donaldson Smith during his latest expedition from Somaliland by Lake Rudolf to the Upper Nile. Twenty-three species were enumerated, and five forms described as new. Dr. Smith had also obtained some fine examples of the true Bohor of Rüppell (*Cervicapra bohor*) and of the Bushbuck described by Heuglin as *Tragelaphus bor*, which proved to be a tenable sub-species of *T. scriptus*.—Mr. W. L. Distant read a paper on the Rhynchota belonging to the family Pentatomidæ in the Hope Collection at Oxford. It constituted a revision of the catalogue of the Hope Collection written by the late Prof. Westwood in 1837. All the specimens had been examined by the author, and the species relegated to modern genera and much synonymy removed, while several new genera were described in the paper.—A communication was read from Mr. R. C. Punnett, containing an account of the Nemerteans collected by Prof. Haddon in Torres Straits. They comprised examples of seven species, four of which had been previously described, whilst the remaining three were new.

Royal Meteorological Society, November 21.—Dr. C. Theodore Williams, President, in the chair.—A communication was read from the International Meteorological Committee inviting observations of the form, amount and direction of the clouds on the first Thursday of each month during 1901, as well as on the preceding and following days. These observations are to be made in connection with the balloon ascents which will be carried out under the direction of the Aërostation Committee.—Mr. R. H. Curtis exhibited an improved mounting for the lens and bowl of the Campbell-Stokes sunshine recorder, by means of which the glass ball can be quickly and accurately placed centrally in the bowl, where it is secured by clamping screws.—Mr. W. H. Dines read a brief paper on the weekly death-rate and temperature curves, 1890-99. He exhibited diagrams showing the death rate of the thirty-three great towns of England, and also curves of the temperature at Greenwich. The author is of opinion that, from the health point of view, the English climate is one of the best in

the world, and this is proved by the relatively low rate shown in these curves. A pleasanter climate may well be found, but the majority of health resorts to which Englishmen resort in the winter have a higher death rate than London has at the same season, and a far higher rate than any of the country districts of the British Isles.—Mr. H. Mellish also read a paper on the seasonal rainfall of the British Islands. After referring to what had already been written on the subject by others, he proceeded to discuss the data contained in the "Tables of Rainfall, 1866-90," published by the Meteorological Council. He concluded by saying that, as regards the relation between the amount which falls in the wettest and the driest month at any station, it seems to be generally the case that the range is larger for wet stations than for dry ones.

Entomological Society, November 21.—Mr. G. H. Verrall, President, in the chair.—Mr. H. W. Andrews exhibited *Atherix crassipes*, Mg., a Dipteron new to the British list, taken near Ticehurst, Sussex. Mr. Verrall remarked that it was a distinct species, and, like *Leptis*, affected the leaves of alder.—Colonel Yerbury exhibited *Anthrax paniscus* and *Tabanus bromius*, bred from a lepidopterous pupa found in sand at St. Helen's, Isle of Wight, and a new species of Cordylura, taken at Aviemore in July 1899 and June 1900.—Mr. L. B Prout exhibited three male specimens of *Proutia betulina*, Z , and two of *P. eppingella*, Tutt, bred from larvæ taken this season in Epping Forest. He remarked that both species occurred in the same part of the forest, and the larvæ appeared to be attached chiefly to old hawthorns. Excepting in the smaller size of *P. eppingella*, no superficial difference was observable between the two species. The specimens of *P. betulina*, however, emerged about ten days earlier.—Dr. Chapman exhibited some specimens of considerable interest in relation to the question of correspondence or otherwise of the pupal and imaginal wings of *Aporia crataegi*, showing that at this particular stage the imaginal wings presented the markings of the pupal wing, a set of markings which are in a way the reverse of those of the mature imago. He also exhibited specimens of the wings at a later stage, showing the true imaginal markings developed. With regard to these effects, Dr. Chapman explained them to some extent as analogous to photographic effects. It was quite possible, he thought, that light and heat caused a differential effect through the different coloured areas of the pupa.—Papers were communicated on contributions to a knowledge of the Rhyncota, by Mr. W. L. Distant, and an account of a collection of Rhopalocera made at Zomba, British Central Africa, by Mr. P. T. Lathy.

MANCHESTER.

Literary and Philosophical Society, November 27.—Mr. J. J. Ashworth, Treasurer, in the chair.—Dr. Wilson mentioned a peculiarity to which his attention had been called in reference to the bursting of gauge glasses on the engines in the laboratory at the Owens College. It appears that an interval of perceptible length occurs between the first appearance of a longitudinal crack in the glass, from which the steam issues, and the actual burst. The interval was sufficiently long on one occasion to allow the fireman to shut off the steam before the tube collapsed. If the interval be found to occur generally, it is of obvious importance.

DUBLIN.

Royal Dublin Society, November 21.—Prof. G. F. FitzGerald, F.R.S., in the chair.—Prof. J. Emerson Reynolds, F.R.S., presented notes on some recent advances in chemical science illustrated at the Paris Exhibition.—Mr. J. R. Wigham described a method of burning petroleum under pressure for lighthouses and other places where an extremely powerful light is required, and exhibited a working model of the apparatus.—Prof. J. Emerson Reynolds exhibited a series of photographic slides showing various parts of the Paris Exhibition.—Dr. W. E. Adeney exhibited and described the Michelson Echelon spectroscope.—Mr. R. M. Barrington showed a collection of the wings of birds killed by striking Irish lighthouses in their flight.

PARIS.

Academy of Sciences, November 26.—M. Maurice Lévy in the chair.—Action of the earth's magnetic field upon the behaviour of a magnetised chronometer, by M. A. Cornu. As the result of the experiments cited, the conclusion is drawn that it is possible to correct the action of a magnetic field upon a magnetised chronometer, either by a correction formula or by the use of compensators.—On the existence of the nitrides of neodymium and praseodymium, by M. H. Moissan. A claim for priority against M. Matignon.—M. Haller was elected a member of the section of chemistry in the place of M. Ed. Grimaux.—On the definition of certain surface integrals, by M. H. Lebesgue. On fundamental functions and the problem of Dirichlet, by M. W. Stekloff.—On orthogonal systems admitting a continuous transformation group of Combescure, by M. Maurice Fouché.—Solution of a problem of elastic equilibrium, by M. Ivar Fredholm.—On the study of distant storms by means of the telephone, by M. Th. Tommasina. By the use of a coherer and a telephone each change of sign of atmospheric electricity shown on the electro-radiograph of M. Boggio Lera is shown to be accompanied by a sound in the telephone, giving rise to the illusion that the storm is quite close. The apparatus may possibly be of use at sea.—Actinometric measurements at Pamir, by M. B. W. Stankewitch. Observations were made at the passes of Taldik (3590 metres), Kisil Art (4220 metres), and Ak Baital (4650 metres).—On the magnetisation of electrolytic deposits of iron obtained in a magnetic field, by M. Ch. Maurain. Two curves are given, one showing the ordinary magnetisation curve of a deposit obtained as little magnetised as possible, the other the intensities of magnetisation of deposits obtained in constant fields up to 800 C.G.S. units.—Apparatus for localising despatches in wireless telegraphy, by M. Paul Jégou.—Cryoscopic researches, by M. Paul Chroustchoff. The measurements were made with a Callendar and Griffiths electrical thermometer, reading to 0°·0001 C. Experimental results are given for salt, sugar, potassium bromide and sulphate.—New method of estimating arsenic, by M. O. Ducru. In a solution containing ammoniacal salts, and slightly alkaline with ammonia, arsenic acid is completely precipitated by cobalt salts. The precipitate may be treated in one of three ways, dried at 100°, ignited at a low red heat, or the cobalt determined electrolytically, of which the first and third appear to give the best results.—On a general method of separation for the metals of the platinum group, by M. E. Leidié. Metals other than those belonging to the platinum group are eliminated, and the remaining metals transformed into double nitrites. Soda is added to the liquid, and the osmium and ruthenium distilled off in a current of chlorine. The iridium and rhodium are precipitated as double nitrites with ammonium nitrite, and the residual palladium and platinum separated in the usual way.—Direct combination of hydrogen with the metals of the rare earths, by M. Camille Matignon. Neodymium, praseodymium and samarium combine rapidly and completely with hydrogen, the hydrides being dissociable.—On some chlorobromides of thallium, by M. V. Thomas. A description of the method of preparation and properties of the chlorobromide, $TlCl_2Br_4$.—On the selenide of cadmium, by M. Fonzes-Diacon. Crystallised cadmium selenide, CdSe, is rhombohedral, and isomorphous with zinc selenide obtained under similar conditions.—Examination of mineral waters for metals present in minute proportions, by M. F. Garrigou.—On the nitration of di-substituted derivatives of benzene, by M. Ch. Cloez.—Action of nitric acid upon tribromoguaiacol, by M. H. Cousin. Nitric acid gives a quinone, which is the result of a simultaneous condensation and oxidation.—On the presence of seminase in seeds containing horny albumen, by MM. Em. Bourquelot and H. Hérissey. Experiments were made on the seeds of lucerne (*Medicago sativa*) and indigo (*Indigofera tinctoria*). These contain, before germination, a small proportion of a soluble ferment, seminase, capable of liquefying their horny albumen and transforming it into assimilable sugars, these sugars forming the first nutriment of the embryo at the commencement of its development.—Osmotic communication in the normal marine invertebrate, between the internal and external media of the animal, by M. R. Quinton.—The adipose body of the Muscides during histolysis, by M. F. Henneguy.—Experiments on teleogony, by Mlle. Barthelet.—On polymorphism of stems in a single species, by M. Marcel Dubard. The Miocene basalts in the neighbourhood of Clermont, by M. J. Giraud.—The effects of working certain groups of muscles, upon others which do no work, by Mlle. I. Ioteyko. A discussion of the previous note of MM. Kronecker and Cutter upon the same subject.—Seasonal variations of temperature at different heights in the atmospheres, by M. Léon Teisserenc de Bort.

NEW SOUTH WALES.

Royal Society, September 5.—The President, Prof. Liversidge, F.R.S., in the chair.—The language, weapons and manufactures of the aborigines of Port Stephens, New South Wales, with two plates, by W. J. Enright.—The past droughts and recent flood at Lake George, by H. C. Russell, C.M.G., F.R.S. It was shown that at the end of 1874 Lake George was at its maximum depth during the past seventy years, the depth then being 24 ft.; from that date the water gradually decreased, rising sometimes during heavy rains, and on February 25, 1877, the water was only 10 ft. 9 in. deep. At this time the author put up an automatic gauge, which recorded every change until it became too low for the machine to work, and exact measures were then carried on by hand. Meantime the level varied with the seasons, until in 1890, a very wet year, the lake was 12 ft. 11 in. deep; and after this the lake level fell faster than ever recorded before, and on March 28, 1900, the depth was only 0 ft. 10 in., a fall of 12 ft. 1 in. in six years. During 1895 the evaporation was most rapid, the hot and windy weather carried the water away, not only by evaporation but also as spray into the forest, and the total loss of water in that year was 5 ft. 4 in.—Note on an obsidian "bomb," by R. T. Baker. The specimen described in this note is not quite perfect—a portion having been broken off when it was discovered. It has a form quite unusual to those previously recorded from Eastern Australia, but resembles those from Western Australia and the interior of the continent. It is not unlike one found in Tasmania in 1897. It is sub-globose in shape, the surface being much indented with air pores and globulites; it has a very dark green or almost black, glassy appearance, and measures 1 in. in diameter, and ⅝ in. in thickness, and has a specific gravity of 2·456 at 15° C. It was found at O'Connell, near Bathurst, by Messrs. A. Walkes and Lester, some feet below the surface, whilst sinking for gold.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part 2 for 1900, contains the following memoirs communicated to the Society:—

April 9.—W. Voigt: On the present state of our knowledge of the elasticity of crystals (report for the Paris International Congress of Physics).

February 3.—E. Landau: The function $\varphi(n)$ in the theory of numbers, and its relation to Goldbach's theorem.

May 19.—H. Winkler: On the segmentation of unfertilised ova under the influence of sperm-extractives.—G. Mittag-Leffler: On the generalisation of Taylor's theorem.

June 30.—E. Ehlers: Magellanic annelids, collected by the Swedish Expedition to the Straits of Magellan.—J. Orth: Researches at the Göttingen Pathological Institute (Report vii.).

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 6.

ROYAL SOCIETY, at 4.30.—The Histology of the Cell Wall, with Special Reference to the Mode of Connection of Cells. Part I. The Distribution and Character of "Connecting Threads" in the Tissues of *Pinus sylvestris* and other Allied Species: W. Gardiner, F.R.S., and A. W. Hill.—On the "Blaze Currents" of the Frog's Eye-ball: Dr. Waller, F.R.S.—On a Bacterial Disease of the Turnip (*Brassica napus*): Prof. M. G. Potter.—The Micro-organism of Distemper in the Dog, and the Production of a Distemper Vaccine: Dr. S. M. Copeman.—On the Tempering of Iron Hardened by Overstrain: J. Muir.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—Santalenic Acid: A. C. Chapman.—Ammonium Bromide and the Atomic Weight of Nitrogen: A. Scott, F.R.S.—Interaction between Urethanes and Primary Benzenoid Amines: Dr. A. E. Dixon.—The Decomposition of Chlorates. Part III. Calcium Chlorate and Silver Chlorate: W. H. Sodeau.—Nitride of Iron: Gilbert J. Fowler.—The Heat of Formation and Constitution of Iron Nitride: Gilbert J. Fowler and Philip J. Hartog.—Relationships of Oxalacetic Acid: H. J. H. Fenton, F.R.S., and H. O. Jones.

RÖNTGEN SOCIETY, at 8.—Exhibition and Description of a Stereoscopic Fluoroscope and a New Rotary Mercury Break: J. Mackenzie Davidson.

LINNEAN SOCIETY, at 8.—On some New Foraminifera from Funafuti: C. Chapman.—On British Thrifts: G. Claridge Druce.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Continuation of Discussion on Mr. Langdon's paper.

FRIDAY, DECEMBER 7.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Dock Gates: F. K. Peach.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. II. Dorsetshire: Dr. A. W. Rowe.

MONDAY, DECEMBER 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Expedition to the Barotse Country and through Africa to the Nile: Major St. Hill Gibbons.

SOCIETY OF ARTS, at 8.—Electric Oscillations and Electric Waves: Prof. J. A. Fleming, F.R.S.

TUESDAY, DECEMBER 11.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Signalling on the Waterloo and City Railway; and Note on the Signalling of Outlying Siding Connections: A. W. Szlumper.—Signalling on the Liverpool Overhead Railway: S. B. Cottrell.

WEDNESDAY, DECEMBER 12.

SOCIETY OF ARTS, at 8.—The Treatment of London Sewage: Prof. Frank Clowes.

THURSDAY, DECEMBER 13.

ROYAL SOCIETY, at 4.30.—*Probable* papers: On the Spectrum of the More Volatile Gases of Atmospheric Air, which are not Condensed at the Temperature of Liquid Hydrogen. Preliminary Notice: Prof. Liveing, F.R.S., and Prof. Dewar, F.R.S.—Additional Notes on Boulders and other Rock Specimens from the Newlands Diamond Mines, Griqualand West: Prof. Bonney, F.R.S.—The Distribution of Vertebrate Animals in India, Ceylon and Burma: Dr. W. T. Blanford, F.R.S.—Elastic Solids at Rest or in Motion in a Liquid: Dr. C. Chree, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—The Syzygetic Theory of Orthogonal Bivariants: Prof. Elliott, F.R.S.—On Discriminants and Envelopes of Surfaces: R. W. Hudson.—Note on the Inflexions of Curves with Double Points: H. W. Richmond.—On some Properties of Groups of Odd Order, ii.: Prof. Burnside, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Possible continuation of Discussion on Mr. Langdon's paper.——*Time permitting*: Rapid Variations in the Current through the Direct Current Arc: W. Duddell.

CHEMICAL SOCIETY, at 8.30.—Rammelsberg Memorial Lecture: Prof. H. A. Miers, F.R.S.

FRIDAY, DECEMBER 14.

PHYSICAL SOCIETY (Royal College of Science), at 5.—(1) Electric Inertia; (2) The Effect of Inertia on Electric Currents in a Rotating sphere: Prof. A. Schuster, F.R.S.—Exhibition and Description of a Quartz-Thread Gravity-Balance: Prof. R. Threlfall, F.R.S.—On the Theory of Magnetic Disturbances by Earth Currents: Prof. A. W. Rücker, F.R.S. Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents: Dr. R. T. Glazebrook, F.R.S.—The New Physical Laboratories of the Royal College of Science: Prof. A. W. Rücker, F.R.S.—Exhibition of a Set of Half-Seconds Pendulums: W. Watson.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Power-Gas and Large Gas-Engines for Central Stations: H. A. Humphrey.

SATURDAY, DECEMBER 15.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—Notes on the Mollusc *Paludestrina jenkensi*, Smith, in Essex and elsewhere: A. S. Kennard and B. B. Woodward.—Aquatic Autocrats and Fairies (Lecture): Fred. Enock.

CONTENTS.

THURSDAY, DECEMBER 13, 1900.

ORGANOGRAPHY AND ITS RELATIONS TO BIOLOGICAL PROBLEMS.

Organographie der Pflanzen, insbesondere der Archegoniaten und Samenpflanzen. Von Dr. K. Goebel. Zweiter Theil. 2 Heft: Pteridophyta und Samenpflanzen. Mit 173 abbild. im text. Pp. xvi + 385 to 648. (Jena: Gustav Fischer, 1900.)

THE volume before us forms a further instalment of the large treatise on the organography of plants upon which Prof. Goebel is engaged. The part just published deals with the vegetative organs of the flowering plants, and, in a lesser degree, with the sporophyte and gametophyte of the vascular cryptogams.

It is needless to remark that the book teems with information, and, as might be anticipated, the author has drawn largely, for purposes of illustration, on the rich stores of material collected by him during his travels in various parts of the world. It is possible, however, that a layman on reading the book would arrive at the conclusion that in this particular field (of organography) other botanists had displayed far less activity than might have been expected from them, and would thus give them less credit than a closer acquaintance with either literature or the class-room would show they deserved.

The plan of the book is partly morphological, but woven into the morphological warp there is also the biological woof, and the author has emphasised, in a way which few could have done so well and, perhaps, no one more fully, the interdependence of these two groups of factors which so largely determine the actual form of existing plants. Goebel has long been known as an exponent of the concrete, and throughout the treatise one constantly finds traces of his antagonism towards that idealism into which, if the function of an organ be neglected, the morphologist is even still apt to stray.

Whilst tracing the various modifications which a given structure—*e.g.* a root—may exhibit in different plants, or in different parts of the same individual, the author constantly insists that these are, in fact, due to a deviation from the ordinary course of growth which commonly culminates in the formation of a normal root. Similarly, though it is more difficult to prove the point owing to their greater variety (depending on their more varied environment), the author argues that the modified leaf structures, scales, thorns, and so on, are brought about by causes acting on the developing primordium of what would, if unchecked, become a foliage-leaf. This latter is for Goebel the actual typical leaf, and from it, by an exaggeration or attenuation of parts which are already recognisable during its earlier stages, the modification occurring in any given example proceeds. He strenuously opposes the view advocated by some writers that the leaf-primordium is an indifferent structure, and regards it as normally destined to give rise to an ordinary leaf. He has himself, more, perhaps, than any one else, shown how easy it is in some cases to interfere with those causes or sequences of events leading to the modification of such an organ, and thereby to effect a reversion in favour of the more primitive organ to take place. Probably most people would be inclined to admit that, on the whole, the main lines of evidence go to prove that the obvious assumption made by Goebel in this connection with regard to the original character of the organ is a valid one.

It must, however, be confessed, and any one at all conversant with contemporary literature will recognise the fact, that there exists some danger of attaching a one-sided importance to the readiness with which organisms adapt themselves to the exigencies of a changed environment. For the response in form and structure is often so direct and obviously purposeful that more stress is apt to be laid on the stimulus itself than on the nature of the body to be stimulated, with its complex and varied mechanism, and there are some who have gone so far as to read into this purposeful variation an immediate explanation of the formation of new or incipient varieties; as though the real fact which mainly stands in need of analysis were not the very one constituted by this self-same *purposeful* character of the response. And indeed it would appear, upon reflection, that this form of response is itself the result of the operation of natural selection which has acted by eliminating the chance of leaving descendants from all those competitors in whom the reaction to a given set of conditions happened to fall short of a certain standard of perfection. It need not necessarily follow that all must have varied in an identical manner, but those that failed to comply, by *some* suitable change or another, with the requirements imposed by the new conditions, must inevitably be ousted by their more gifted rivals, and if these assumed changing conditions periodically recur, then the process of elimination will result in those only being left in which the power to respond accurately (*i.e.* purposefully), and it may be rapidly, to a particular change has been best developed and cultivated.

It is obvious that a similar result, *mutatis mutandis*, would follow if a complex variety of stimuli be substituted for the simple case touched on above, and thus a protoplasmic mechanism is gradually selected and perfected which, when stimulated by any means to which there can be a response at all, will reply by the corresponding reaction normal for that species or race. But though normal in kind for the race, its degree will vary in different individuals, as any one can readily prove by direct observation. Hence it at once becomes subject to the operation of natural selection. Naturally, so long as a particular stimulus is absent the corresponding response, however well tuned and ready, will remain in abeyance as a latent potentiality.

A study of plants reveals numerous examples of this. Amphibious plants frequently are able to assume alternative characters, respectively fitted for either a terrestrial or an aquatic habit, and it depends entirely on the nature of the stimulus arising from the environment as to which of the two types of structure shall appear. Such plants, during their species-life, have been repeatedly exposed to vicissitudes of a somewhat extreme character, and the latent ability to change so as to adapt themselves more fully to altered circumstances must have played no unimportant part in securing the survival of their race. Many other examples could be quoted to show how important for stationary beings like plants is the possession

of a very plastic organisation, that is, one which will respond readily and *accurately* to the demands of the external conditions of life. For plasticity is clearly only of use (and therefore will come to a like extent within the purview of natural selection) in so far as it will provide the organism with the power of striking the right note in response to a particular call.

On the other hand, there are plants which may have become, for example, specially selected on account of their ability to flourish in dry, hot, desert lands. Such plants might be expected to retain slender powers of responding in a manner favourable to the continuance of life under opposite hygrometric conditions; and every one is aware how extremely intolerant of moisture are the cacti and some other xerophytic plants. Nor is this surprising, seeing how trivial a part the development of a purposeful adaptation to satisfy the needs of a damp environment can have played in their ancestral experience, and indeed the chance of any individual amongst them possessing the power of responding quickly and appropriately to such conditions, to which they are never exposed, is an exceedingly remote one. It is otherwise with species that inhabit regions which, though usually dry, are occasionally or periodically exposed to different conditions. That the plants living in such places, though they may be mainly of a xerophytic habit, nevertheless retain the faculty of withstanding wet is precisely what one would have been led to anticipate, and there are plenty of examples in which the alternation of dry and wet seasons is accompanied by a change in habit analogous to that exhibited by our own trees in summer and winter respectively. An immense weight of evidence has been accumulated by those who have helped to elucidate these matters which goes to prove that the power to vary in any given direction is possessed in an unequal degree, not merely by individuals of the same species, but even in those growing side by side, and thus apparently exposed to very similar conditions.

This fact at once emphasises the importance of the preexisting *internal* factor of variation, and it also explains the existence of a criterion which can determine what individuals shall survive in the struggle imposed by new or changing conditions. The particular variation elicited in any given instance is merely the outward and visible sign of the operation of an inward organisation or mechanism. It is the latter which, forming an integral part of the parental constitution, will be transmitted to the offspring. And if those individuals which possess the special organisation in the highest degree are thereby enabled to leave the most vigorous or favourably situated descendants, that character, which is its outward token, will become correspondingly strengthened till it comes to form a mark of the race. It is the function of the environment to prove the individual capacity in that contest where the race is emphatically to the swift and the battle to the strong.

Hence, it would seem that not variability only, but that special (purposeful) form of it which enables so many organisms to make suitable responses to divergent conditions of life ought to be, as the outcome of the effect of natural selection, a feature of very general occurrence; and it ought to be most strongly developed in organisms living under changing or changeable conditions, and such is found to be the case. One may almost assert that the purposefulness of a particular reaction is a measure of the perfectedness of the stimulable mechanism, itself a heritage transmitted through a long ancestral line of individual bodies.

This view of the matter is obviously in no wise altered, if we admit the occurrence of sudden or discontinuous variations. For these also are themselves congenital in their origin, and all that the environment can do is to encourage the manifestation of a variation (if a favourable one) in as high a degree as the organism can develop it. Nor is the position affected if we allow that a structural reaction may proximately result from a change in the metabolic processes of the organism, such as Sachs, and Goebel following him, have supposed. In fact, there are some familiar instances which hardly admit of any other explanation, as, for example, when different kinds of galls are produced on the same individual oak-tree by different insects. Facts such as these merely shift inquiry to another stage, and it is certainly not less difficult, in these and similar cases, to account for the particular antecedent reactions going on within the plant in such a way as to produce a substance capable of acting as an appropriate stimulus, which shall provoke a reaction in the plant useful to the grub which originates it.

Into the questions as to the origin of the causes of variations themselves, this is naturally not the place to enter; nor does a consideration of the problems concerned with the nature of those variations which may arise correlatively, or which are more or less obscurely conditioned by remote causes residing within the organism itself, and which may appear suddenly, without any immediate reference to their adaptedness to contemporary needs, fall within the scope of this article. It is enough to emphasise the point that the occurrence of purposeful reactions to specific stimuli is really in complete harmony with the operation of natural selection acting through the medium of a congenitally varying organisation.

Turning again to the subject-matter of Prof. Goebel's book, one finds that not only is it replete with interesting results of biological inquiries, but that there are scattered through its pages excellent little essays on morphological subjects. As an example of the former may be cited the explanation of the mechanism which brings about the dehiscence of the antheridia, a topic which has already formed the basis for investigations published from the author's laboratory. The instance of Azolla, too, in which the lower leaf lobe is shown to have an absorbent function, is attractive when the analogous case of Salvinia is recalled.

The critical treatment of the structure of the grass embryo is an admirable piece of comparative morphology. Prof. Goebel regards the cotyledon as consisting of the scutellum, epiblast and the sheath or coleoptile. His views are supported by evidence drawn from a consideration of a large number of other monocotyledons, especially the Cyperaceæ, and whether one agrees with his conclusions or not, one cannot but praise the way in which the evidence for them is collected and marshalled. The views put forward as to the homologies existing between the cells formed within the germinating microspores of some of the vascular cryptogams will probably provoke criticism, as will also the suggested phylogeny

of the gymnosperms, which the author appears to regard as derived partly from the Ferns and partly from the Lycopods.

As regards the book, viewed as a whole, it is impossible not to feel that, in spite of—perhaps partly in consequence of—its extraordinary wealth of illustration, it does not help us much farther towards a more general conception of the value and wider relations of organography as a whole. But, nevertheless, the experimental line of inquiry in this field, which Goebel himself has so ably pursued, is one which will certainly prove a fruitful one, judging from the results which have even yet accrued. And for the clear indication of this, as well as for the bringing together such a vast store of facts, the author has thoroughly earned the gratitude of his fellow-workers. It is just because there is so much of good in the book that it is difficult to avoid giving expression to that kind of gratitude which still hopes for something yet more satisfying. J. B. FARMER.

THE HISTORY OF THE DEVIL.

The History of the Devil and the Idea of Evil. By Dr. Paul Carus. 8vo. pp. xvi+488. (London: Kegan Paul and Co., Ltd. Chicago: The Open Court Publishing Company, 1900.)

THE volume before us is one of considerable interest, but we must say at once that we think the history of the Devil and of the idea of evil should have been treated in a manner different from that which has been adopted by Dr. Paul Carus. The discussion of the idea of evil is a matter for the philosophical thinker, it seems to us, and the subject cannot be threshed out in detail in a single volume by any writer, however able he may be; the history of the manner in which the Devil, *i.e.*, the personification of evil, has been depicted by various peoples at various times in various places over the earth, is quite a different subject, and is, likewise, one which cannot be treated adequately in a single small volume. Dr. Carus, however, has tried to deal with *both* sides of this complex subject in one volume, and, it must be confessed, he will, in consequence, not satisfy either the philosopher or the iconographer. His book is well printed and well illustrated—though we certainly do not admire the shadowy "ghost" pictures printed in a sickly green colour on several of the pages—and to many readers it will be of interest, and probably of use also, for it may stimulate them to investigate the subject for themselves. In eighteen chapters, which vary considerably in length, the history of the Devil and the idea of evil are discussed in connection with the evidence derived from pictures, reliefs, &c., from Egypt, Akkad, Babylonia, Persia, Judea, India, China, Europe, and other countries, but Dr. Carus has not collected all the facts which he ought to have gathered together, and his deductions from those he gives are hardly correct. We do not think that "the belief in good spirits tended towards the formation of the doctrine of Monotheism," or that "the belief in evil spirits led naturally to the acceptance of a single supreme evil deity." Prehistoric man peopled all earth, air, sea and sky with spirits, some of whom were supposed to be hostile to him, and others benevolent; and he regarded a spirit as good or evil according to whether it did him good or evil. When a series of good harvests came to him, or he was singularly fortunate in love, or the chase, or war, he made up his mind that the good spirits had succeeded in destroying the power of those who were evil. In process of time, to certain evil and to certain good spirits extraordinary powers were ascribed, and eventually the idea of the existence of a prince of evil, as well as of a prince of good, was formulated; terror and ignorance were the chief constituents in the worship of primitive man, and physical and moral attributes, as well as cause and effect, were often confounded by him.

Dr. Carus regards the old Egyptian god Set as the equivalent of the Devil of the later peoples of the West, but this is only partly true. He was a nature power and was the twin brother of Osiris according to one legend, and the twin brother of Horus the Elder according to another. He was the male counterpart of Nephthys who, as is well known, was not hostile to Osiris, and he must not be confounded with Âpep, the mighty enemy of Rā, the Sun-god; Set and Horus together held up the ladder whereby the deceased entered heaven, and both gods gave him a helping hand in mounting it. Dr. Carus is mistaken when he says that Set "was converted into Satan with the rise of the worship of Osiris." We know nothing about the rise of the worship of Osiris, but we learn from the Pyramid Texts that in the fifth dynasty, when the worship of Osiris was universal in Egypt, Set was regarded as a benevolent god and a friend of the deceased. In speaking of Akkad and the early Semites, Dr. Carus is either credulous or rash, for, after saying that the Babylonians "possessed several legends which have been received into the Old Testament," he mentions a legend of the Tower of Babel and of the "destruction of corrupt cities by a rain of fire," reminding us of Sodom and Gomorrah. The text on which he relies for the legend of the Tower of Babel is, of course, K. 3657 in the British Museum, but a recent examination of the tablet proves that it has nothing to do with the Tower of Babel; as for the legend of the cities which were destroyed by "a rain of fire," we cannot imagine what the authority can be. We may mention, in passing, that many of Dr. Carus's authorities are altogether obsolete, and it is possible that one of them has led him astray on this point. His interpretations of Babylonian scenes, too, are not always correct. Thus on p. 40 the "Chaldean Trinity" is not blessing the tree of life, but is merely appearing above the conventionalised representation of the palm tree to the priest who is worshipping before the image of the god; similarly, the statement (p. 46) that the bronze tablet of the de Clercq Collection is a representation of "the world in the clutches of an evil demon" is erroneous. Any account of the demonology of the Assyrians and Babylonians which does not take into account the *Shunpu* and *Maklu* series of magical tablets which have been recently published by Tallquist and Zimmern must of necessity be most incomplete, and we are not a little surprised that Dr. Carus should have undertaken the task without doing so. The demonology of the Israelites is dismissed in nine pages, and this section of the book is most disappointing; in recent years many workers have investigated the Hebrew side of the subject of devil-lore, and an extremely interesting chapter might have been compiled from their writings. The famous

old work of Eisenmenger alone would have afforded him abundant material for a very long essay wherein every statement might have been founded upon fact.

In the chapters of Dr. Carus's work which are devoted to the "Dawn of a New Era" and "Early Christianity," the same complaint must be made, *i.e.*, he has not used existing materials. Who in these days would attempt to write about Gnosticism without giving a good account of the Pistis Sophia, or of the Book of Ieu, works from which the most valuable information on the subject is to be derived? It seems almost as if Dr. Carus had written his book to suit the pictures which he gives, without paying any attention to the system or arrangement of his work. In a treatise of such pretensions we should expect the account of the demonologies of the various Semitic nations to be kept together, and, as the devils of the Gnostics and early Christians were descendants of the denizens of the Egyptian underworld, they ought to have been described in a connected and systematic manner. It is doubtful how far the histories of the Inquisition and of the persecution of witches have any right to be in a book of this kind, but if they have, they should have been greatly shortened; in fact, Dr. Carus's work needs careful editing by a skilful but somewhat severe editor. As a picture book it is interesting enough, but as a scientific contribution to the history of an interesting and important subject it is, in our opinion, of little value.

SIR H. MAXWELL'S "MEMORIES OF THE MONTHS."

Memories of the Months. Second Series. By the Right Hon. Sir Herbert Maxwell, Bart. Pp. xv + 295. Illustrated. (London: E. Arnold, 1900.)

IT falls to the lot of but few among us to be all-round sportsmen, good naturalists, entertaining and versatile writers, and philosophers to boot; and yet all these varied and valuable accomplishments are the attributes of the author of the delightful and entertaining volume before us. A few years ago, as the author tells us in the preface, he published selections from his note-books of several seasons under the title quoted above, and these met with such a favourable reception that, at the request of numerous readers from both sides of the Atlantic, he has been induced to print a second series. And the public are decidedly the gainers by this resolve. For whether discussing the kind of salmon-fly best suited to any particular season or river, the utility or otherwise of birds or mammals commonly persecuted by the farmer and the gamekeeper, the kinds of shrubs and plants best suited to escape the depredations of rabbits, the ruthless slaughter of egrets for the sake of their so-called "osprey" plumes, or the accident by which the skeletons of the iguanodons of Bernissart were preserved for the delectation and wonderment of the present generation, he is equally at home, and equally free from any suspicion of dulness and pedantry.

Nothing, indeed, seems to come amiss to Sir Herbert i the matter of a text, and he has the rare faculty of making an extract from some abstruse scientific paper as full of interest as are his observations on the mammals, birds and fishes with which he has come in contact in the ordinary course of a country life or in his field sports.

Among the subjects to which the author has paid special attention is the so-called vole-plague, which wrought devastation some years ago over wide districts in Scotland. Of the committee appointed to investigate the causes of this invasion, and, if possible, to suggest remedies, he was appointed chairman. And he gives a graphic account of the scene which met the eye during the visits of the committee to the afflicted area, mentioning the extraordinary number of short-eared owls which flocked to the feast, and of their equally remarkable fecundity as its result. Lappwings, too, are birds which come in for a special share of his attention; and although he apparently considers that much harm has not been done thus far, yet he urges that shooting a bird at one season and taking its eggs at another, or even conducting both operations simultaneously, is a sure road to its eventual extermination. While deprecating any interference with the collecting of these plovers' eggs, he suggests that the slaughter of the birds themselves should be prohibited.

An enthusiastic angler, the author holds out hopes of the possible rehabilitation of the salmon in the upper reaches of the Thames, stating that even at the present day the condition of the water at the mouth of that river is such as to offer no barrier to the upward passage of the fish. But he points out that as there are now no salmon-rivers discharging in the neighbourhood of the Thames estuary, it is essential that young salmon must be turned down in that river itself, when there would be hope that some of them would return after their first excursion to the sea. From Thames salmon the transition is easy to the question as to whether *Salmo salar* really abstains from food while in fresh water. In regard to this latter point, Sir H. Maxwell states that the experience of many anglers is practically in accord with the results of the investigation carried on by the Scottish Fishery Board, as detailed in a "blue-book" published in 1898, namely, that salmon do, as a rule, fast during the period in question. Against this evidence is, however, advanced the undoubted fact "that salmon in fresh water do take and swallow worms, minnows, and similar objects." And the pertinent question is asked with what object they take them if not to eat. "The simplest solution is probably the true one—namely, that even a physiological fast is compatible with occasional and irregular impulses of appetite, which exactly corresponds with the well-known capriciousness of salmon in taking any lure."

But to follow the author further in his interesting discussions on fish and fishing would spin out this notice to an inordinate length. And it ought to be mentioned that the mole is one of the animals he considers should be protected rather than destroyed, as it appears to be of incalculable value in destroying the larvæ of "daddy-long-legs" and other equally noxious grubs. On the other hand, Sir Herbert has not a single good word to say for the rabbit, which he terms an "accursed" creature.

Hitherto we have referred to the author's zoological and sporting notes; but an equal degree of interest is taken by him in botany, and the mention of the extraordinary abundance of holly blossom in the home counties during the summer of 1899, coupled with his observations on

the remarkable "mimicry" of the plane by the sycamore, will serve to indicate the amount of attention bestowed by the author on botanical subjects. The incident related on page 87, narrating how a Scotch minister caused all the daffodils in his churchyard to be mown down because his wife regarded yellow as a vulgar colour, is a curious example of mid-century "æstheticism." To those fond of their gardens, the hints given as to the kinds of shrubs and herbaceous plants that flourish best in this country will be acceptable.

With the number of subjects on which the author touches it would not be surprising if he fell here and there into error. And yet there are but two passages which we have found occasion to criticise in this respect. In the first of these (page 89) we fail to realise how ice is likely to have had any share in the transport of the remains of the Bernissart iguanodons. The other is the statement (p. 46) that the nightjar, or goatsucker, is a relative of the swallow, whereas it is, of course, to the swifts that this bird is really allied. That the statement is not due to an accidental slip of the pen is proved by its repetition on page 233. These, however, are but trivial blemishes. And to whatever page he may turn, the reader can scarcely fail to be interested in what the author has to tell him. Whether, indeed, to while away an idle half hour at home, on a railway journey, or as a companion in the field, it would be difficult to find a more entertaining and instructive work of its kind. The epithet "delightful" suits it exactly. R. L.

OUR BOOK SHELF.

Cinématique et Mécanismes, Potentiel et Mécanique des Fluides. Cours Professé à la Sorbonne. Par H. Poincaré; redigé par A. Guillet. Pp. i + 385. (Paris: Carré et Naud, 1899.)

THIS book is edited from a course of lectures given at the Sorbonne. The first part deals with the kinematics of rigid bodies in two and in three dimensions, including the theories of roulettes, of acceleration centres and of relative motion; and concludes with a chapter on simple mechanisms. These are all well-worn topics, and afford little opportunity for novelty of treatment. In the few pages devoted to finite rotations we notice, however, an elegant method of investigating Rodrigues's formulæ which is, at all events, not current in this country. The exposition is marked throughout by the author's usual facility, and the illustrations are well chosen. A severe taste might perhaps take exception to the way in which analysis and geometry are continually mixed up in the proofs, but a course of lectures intended primarily for a special class of students is not to be judged by the same canons as a formal treatise.

The second part gives, in about 180 pages of large type, a rapid sketch of the theory of the potential, the attraction of ellipsoids, hydrostatics and hydrodynamics. A number of leading propositions are introduced, but the treatment is necessarily fragmentary, and in some instances it might be difficult to account for the precise selection which has been made. The brief chapter on hydrodynamics is disappointing. We notice, in particular, that Poisson's proof of Lagrange's velocity-potential theorem is reproduced without a word of warning as to its defects; and on p. 330 we have the following mysterious sentence: "On a discuté la question de savoir si un liquide visqueux est encore soumis au théorème de Lagrange; *les opinions sont partagés!*" Again, on p. 339, the remark: "Il est impossible de déterminer théoriquement le coefficient de contraction," might surely be qualified. It is a little strange to find the labours of Stokes and Kirchhoff on these points entirely ignored, even in an informal publication like the present. The absence throughout of all reference to authorities is, indeed, to be regretted; such references can, of course, be only sparingly made in actual lectures, but they might well be introduced in the process of editing.

It would be ungracious not to add that although, from the nature of the subject, the present treatise is not likely to excite such widespread interest as some of its predecessors, probably few readers will be found to lay it down without a fresh feeling of admiration for the energy and versatility of its author. H. L.

A Contents-Subject Index to General and Periodical Literature. By A. Cotgreave. Pp. xii + 744. (London: Elliot Stock, 1900.)

THIS is an attempt to bring together and classify in alphabetical order the noteworthy contents of periodicals and some other publications.

Several indexes to periodical literature are in existence, and are appreciated by people who have cultivated the habit of verifying references. Mr. Cotgreave has produced an index which will prove a handy and inexpensive guide, and an examination of it suggests that a similar work, prepared by a body of experts instead of one man, and issued periodically, would be of distinct value.

The index is not complete—nor does it pretend to be, but it is a praiseworthy attempt to classify a mass of heterogeneous articles, books and papers into subjects. Any one desirous to know a few contributions on any subject has only to refer to the index and he will find some to serve his purpose, though not always the best. We are only concerned with the scientific subjects, and have examined the entries from this point of view. The result is not very satisfactory, for some of the best contributions to science do not appear—at any rate where we should naturally expect to find them. Why should Barff's "Chemistry" and Reynolds' "Chemistry" be selected as containing accounts of the composition of air, while many other much better descriptions have been published? Why, again, should Johnston's "Chemistry of Common Life" be the only book given under the composition of air? Under physical geography there are six titles, three of which are unimportant; the only title under natural philosophy is Mitchell's "Orbs of Heaven"; an article on cellulose is classified under natural science; Balfour Stewart's Physics Primer is the only book cited under the title "laws of electricity"; Ashby's "Physiology" is the only reference given for a description of the metric system; the British Museum catalogue and introduction to the study of meteorites is not mentioned under meteorites; and many other similar cases could be given. We understand, of course, that the index is an eclectic one, and are willing to acknowledge that much work must have been expended in its preparation; but its limitations and imperfections must nevertheless be pointed out. If it is borne in mind that the book only contains a general survey of literature, it will be found of service.

Workshop Mathematics. By Frank Castle, M.I.M.E. Part i., pp. viii + 154. Part ii., pp. ix + 177. (London: Macmillan and Co., Ltd., 1900.)

PROF. PERRY'S persistent advocacy of a system of mathematical instruction adapted to modern requirements is bearing fruit in the shape of text-books, which will probably do more to induce teachers to adopt rational methods than the most convincing statement in favour of them. Mr. Castle has already prepared a book on "Practical Mathematics" which covers substantially all the subjects in the syllabus drawn up by Prof. Perry for

the Board of Education, South Kensington. The two little books under notice have been written in the same spirit, and contain some sections from the previous volume, but the treatment is more elementary and many new exercises are given.

In Part i. the subjects dealt with belong to arithmetic, algebra and the mensuration of parallelograms, triangles and polygons. Prominence is given to contracted methods, use of decimals, and explanations of algebraical expressions. Scales, calipers, and other simple measuring instruments are described in the chapters dealing with mensuration, and their use is well exemplified. Part ii. is devoted to logarithms, the slide rule, mensuration of circles, ellipses and irregular plane figures, volumes and surfaces of solids, more difficult algebraic expressions than are given in Part i., and the graphic representation of varying quantities. Among noteworthy points in this part may be mentioned the clear account of uses to which a slide rule may be put, the descriptions of planimeters, and the ingenious uses made of squared paper in the section on graphic representation.

The books are full of exercises illustrating the applications to every-day problems of the principles described, and at the end of Part ii. a set of tables of logarithms and anti-logarithms is given, to enable the student to work out problems by logarithms when convenient. It would be too much to say that the books contain an ideal course of mathematics for technical students, but they may fairly claim to provide far more inspiring information and serviceable exercises than can usually be found in text-books designed for use in schools.

Exercises in Natural Philosophy, with Indications how to Answer them. By Prof. Magnus Maclean, D.Sc., F.R.S.E. Pp. x + 266. (London: Longmans, Green and Co., 1900.)

The ability to deal with quantitative results is an essential qualification of a student of physical science. Laboratory work provides some material for the exercise of this faculty, but it is often necessary to use data obtained by others, and to work out problems other than those which are afforded by the student's own practical work. Dr. Maclean's book contains numerous exercises of this character, covering most of the subjects studied in courses of physical science, and many worked-out examples of typical cases suggesting methods of solution for those which follow. Wisely used, the book will provide teachers with useful exercises in mathematics applied to physics, and will make a convenient supplement to text-books in which such exercises are not given. Many text-books do contain questions upon the subjects dealt with, but even in these cases some good additional problems for solution could be selected from the book under notice.

Tables of useful data and physical constants are printed at the end of the volume.

Memoirs of the Countess Potocka. Edited by Casimir Stryienski. Authorised translation by Lionel Strachey. Pp. xxiv+253. (New York: Doubleday and McClure Company, 1900.)

These memoirs cover the period from the third partition of Poland to the incorporation of what was left of that country with the Russian Empire. They deal with episodes—more or less romantic and interesting—in Countess Potocka's career, referring to journeys, Court balls, and Napoleon I., between 1812 and 1820. The authoress died, at the age of ninety-one, in Paris, where her brilliant salon held no insignificant place in the gilded pleasures of the Second Empire. There is little of interest to scientific readers in the memoirs; but one or two incidents referring to astrologers are amusing.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Inverse or "a posteriori" Probability

The familiar formula of Inverse Probability may be stated as follows:—

Let the probabilities of a number of mutually exclusive causes or conditions $C_1\ C_2 \ldots C_r$ be $P_1\ P_2 \ldots P_r$ respectively, and the probabilities that if $C_1\ C_2$, &c., are realised, an effect or result E will happen be $p_1\ p_2 \ldots p_r$ respectively; then if E happens, the probability that it happened as a result of C_r is

$$\frac{P_r p_r}{\Sigma P p}.$$

The current proofs of this are unsatisfactory, more especially one based on a theorem of James Bernoulli; for even if the ordinary statements of the principle of this theorem were correct, which must be disputed, the argument by which it is applied to Inverse Probability is demonstrably erroneous.

In consequence of the difficulty felt about the usual proofs, there seems to be a tendency to drop the subject, as unsound, out of mathematical theory.

Now it would not be hard to show that there is no essential difference of principle between problems of Inverse Probability and those of ordinary Probability, and therefore it can hardly be doubted that the former should admit of as accurate mathematical treatment as the latter.

The following is offered as a proof which can claim the same rigour as the theorems of ordinary Probability, and illustrates the identity of principle in both kinds of Probability:—

Let A and B be contingencies which are not independent, then by a known theorem

Prob. concurrence of A and B = Prob. A × Prob. of B if A happens.

Or, as it may be shortly expressed,

Prob. A with B = Prob. A × Prob. B if A.

Similarly

Prob. A with B = Prob. B × Prob. A if B.

∴ Prob. A × Prob. B if A = Prob. B × Prob. A if B.

$$\therefore \text{ Prob. A if B} = \frac{\text{Prob. A} \times \text{Prob. B if A}}{\text{Prob. B}};$$

and this is really our theorem. For put $A = C_r$ and $B = E$.

$$\therefore \text{ Prob. } C_r \text{ if } E = \frac{\text{Prob. } C_r \times \text{ Prob. E if } C_r}{\text{Prob. E}}.$$

But Prob. $C_r = P_r$, Prob. E if $C_r = p_r$, and obviously Prob. E $= \Sigma P p$ by a known theorem.

$$\therefore \text{ Prob. } C_r \text{ if } E = \frac{P_r p_r}{\Sigma P p}.$$

Another demonstration may be given which, though a little longer, is quite simple.

If the whole number of "equally likely" cases with reference to a given contingency E is b, and the number of these in favour of E is a, then the mathematical probability of E is, of course, $\frac{a}{b} = p$, suppose.

Considered as a fraction, $p = \frac{na}{nb}$, where n is any quantity whatever.

Suppose n an integer, as a fractional value does not here concern us. We may consider each of the original "equally likely" cases as including n "equally likely" sub-cases; and then we can interpret the fraction $\frac{na}{nb}$ as we interpreted $\frac{a}{b}$, and say that there are nb new cases equally likely, and of these na are in favour of E.

Obviously, if x is the total number of equally likely cases, the number in favour of the event or contingency is px. Again, if q is the probability that E happens if C happens, this means that q of the equally likely cases of C's happening are in favour of

E ; and so, of course, there must be a total number y of such cases such that qy is an integer.

In the problem before us let P_1, P_2, &c., be reduced so as to have a common denominator b, then $P_1 b$, $P_2 b$, &c., are integers.

Multiply in each fraction $P_1 P_2$, &c., numerator and denominator by n, taking n such that $p_1 P_1 nb$, $p_2 P_2 nb$, &c., are integers. Put $nb = x$.

Then of x equally likely cases, $P_r x$ is the number favourable to C_r. And, as above, the number of these again favourable to E, is $p_r P_r x$, that is, the number favourable to E happening as result of C_r (or "C_r if E") $= p_r P_r x$; and the total favourable to E is $\Sigma P p x$.

Now, if the event E happens, the total of possible cases, of which one or other must be the true one, is clearly $\Sigma p P x$, and by hypothesis none of these cases has any preference over the other, and all are "equally likely;" while the number of them favourable to E resulting from C_r is $p_r P_r x$. Therefore the probability if E happens that it happens from C_r is

$$\frac{p_r P_r x}{\Sigma p P}.$$

It may be noticed that a proof of the theorem that if A and B are not independent, Prob. A with B = Prob. A × Prob. B if A, which is repeated in edition after edition of ordinary text-books, and so seems to have passed muster, is, nevertheless, erroneous.

The formula is proved correctly for two independent events, thus :—

Let a be the number of cases in which the first event may happen, b the number of those in which it fails ; a' the number in which the second may happen, and b' the number in which it fails, the cases for each event severally being supposed equally likely. Each of the $(a+b)$ cases may be associated with each of the $(a'+b')$; thus there are $(a+b)(a'+b')$ compound cases which are equally likely. In aa' of these both events happen ; therefore the probability of both happening

$$= \frac{aa'}{(a+b)(a'+b')} = \frac{a}{a+b} \times \frac{a'}{a'+b'} = \text{Prob. first event} \times \text{Prob.}$$
second event.

It is then added that the above proof may be applied to two dependent events, for we have only to suppose that a' is the number of ways in which after the first event has happened the second will follow, and b' the number of ways in which after the first event has happened the second will not follow. Now if this substitution be made in the above, the first step of the proof will be "each of the $(a+b)$ cases may be associated with each of the $(a'+b')$ cases; thus there are $(a+b)(a'+b')$ compound cases which are equally likely." But this is impossible. Each of the $(a'+b')$ cases is one in which the first event happens, and therefore none of them can be associated with any of the b cases, because these presuppose that the first event has not happened. The $(a'+b')$ cases, in fact, can only be associated with the a cases out of the $(a+b)$, and thus the total number of the compound cases intended is not $(a'+b')(a+b)$. A proof can easily be given on the lines already indicated.

If P_1, p_1, n, and b have the same meanings as before, the whole number of equally likely cases is nb, the part favourable to the first event is $P_1 nb$, and the part of these favourable to the second is $p_1 P_1 nb$ (as above shown), which is therefore the number favourable to the concurrence of the two events. The probability, therefore, of the concurrence is

$$\frac{p_1 P_1 nb}{nb} = p_1 P_1$$

Certain confusions which often arise in the statement and application of the mathematical theory of probability would be avoided if a clear idea were formed of what is exactly meant by the fraction which is said to represent the probability of an event.

A good statement of the ordinary account of it is given in Todhunter's Algebra : "If an event may happen in a ways and fail in b ways, and all these ways are equally likely to occur, the probability of its happening is $\frac{a}{a+b}$, and the probability of its failing is $\frac{b}{a+b}$. This may be regarded as a definition of the meaning of the word probability in mathematical works."

A definition must not assume and use the notion to be defined. Here probability is defined through cases "equally likely to occur" ; but "equally likely to occur" means equally probable, and so the definition assumes the very notion which causes difficulty, the notion of "probability" or likelihood, and of which we require the explanation.

The first thing to settle is the meaning of these "equally likely" cases. Is the equal likelihood a quality in things themselves, or is it something in our minds only? If it is a quality in things it can only mean equal possibility of occurrence or realisation. But if a number of cases, mutually exclusive as intended in the above definition, were in the nature of things equally possible, not one of them could happen. If the claim of any one of them in reality were satisfied, so must the claim of any other, since these claims are equal, and therefore if one happens all must, but by hypothesis if one happens no other can ; thus the only possible alternative is that none of them can happen. (It is precisely on this principle that we decide that the resultant of two equal forces at a point, whose directions include an angle, cannot be in any other direction than the bisector of the angle, and that there can be no resultant of two equal forces which act in opposite directions).

The equal likelihood then intended cannot be anything in the nature of things because it is assumed that one of the equally likely cases will happen. It is really only in our minds, when there is an equal balance of reasons for and against two or more events, and due solely to our ignorance, since if we knew which was to happen there could be no such balance and indecision. This is clear if we consider what is the reason why we pronounce one event more likely or probable than another ; it is because we think there is more evidence in favour of the one than in favour of the other, however the "more" may happen to be measured. Two events are equally likely to us when we know nothing more in favour of the one than we do of the other—when the state of our knowledge and (it is important to add) of our ignorance, is the same for both contingencies. This view agrees with the actual procedure in mathematical examples. If a bag contains n balls, and one is to be drawn "at random," there are said to be n equally likely cases, that is, each of the n balls is equally likely to be drawn. Clearly this only means that as we don't know how the hand is going into the bag, we have no information in favour of the drawing of any one ball as compared with any other, and no information against the drawing of any one ball as compared with any other.

"Equally likely" cases then being such that owing to our ignorance the evidence in favour of any one is no greater or less than the evidence in favour of any other, the meaning of the definition of probability above criticised is evident; it is not a definition of probability, but it is the definition of a certain way of measuring evidence.

We are entitled to say that one event is more probable than another when the evidence before us, being decisive for neither, that in favour of the one seems to us, according to some standard of measurement, greater than the evidence for the other. Now what the mathematical analysis does is not to alter the ordinary meaning of "probability" at all, but to find a standard for the measurement of the more and less in evidence.

The whole possibility before us in any given contingency is divided into a number of cases, "equally likely" or "equally possible," in the sense that they are equal from the point of view of the evidence in favour of each of them ; then if one event has more of these equal possibilities in its favour than another, it has in this sense "more" evidence in its favour, and so in accordance with the usual meaning (as above described) of "more probable," is more probable than the other. And here the "more or less" in the evidence is not a mere "more or less," but has a definite numerical measure. The evidence being, so to speak, divided into equal units, the strength of the evidence in favour of a contingency is measured by the number of these units in its favour. Thus if the total of equal possibilities, one of which must happen, for the events A B and C is n, of which a involve A, b involve B and c involve C, the comparative strength of the evidence in favour of A, B and C respectively is measured by the ratios $a : b : c$, while the strength of the evidence of A, B and C respectively, as compared with the evidence for one or other of them happening (which is certain), is, on the same principle, measured by the ratios $\frac{a}{n}$, $\frac{b}{n}$ and $\frac{c}{n}$.

If, then, we symbolise the strength of the evidence for A, B and C by $\frac{a}{n}$, $\frac{b}{n}$, and $\frac{c}{n}$, and similarly that for one or other

of them happening by $\frac{n}{n} = 1$, these quantities have to one another the ratios required. We then arrive at the true meaning of the fraction which is said in mathematics to be the "probability" of a contingency; and much confusion might be avoided if we called the fraction, not the "probability," but the "*modulus of the evidence*," and the so-called equally likely cases not "equally likely" but "*equi-evidential*," or by some more convenient name conveying the same idea.

But it must be insisted that the above is only one way of measuring the evidence, and is not applicable to all cases. Indeed, the more important matters of daily life usually do not admit of it, for there are qualitative differences in strength of evidence which cannot really be measured quantitatively, and that is why the application of mathematical probability to the testimony of witnesses is so obviously futile.

The solution of every mathematical problem in probability is in the last resort only the finding of a modulus of evidence, in the ratio of the part of the whole number of equi-evidential cases which involve a given contingency, to the whole number of such cases; and with the finding of the modulus the strictly mathematical work ends. Mathematics, as such, has nothing to do with the inclination in our minds to expect the event for which the modulus of evidence is greatest (or "the probability" greatest), or the inclination, when some practical step has to be taken, to act on the hypothesis that the event will happen for which the evidence to us seems strong.

Unfortunately, however, there is too often a tendency to confuse the mathematical measure of the mere state of our minds with the measure of something in reality; and this produces various mistakes—*e.g.* the inclination to expect that the actual proportion of the occurrences of the event will tend to conform to the proportion represented by the mathematical probability, *i.e.* conform to a formula of our ignorance. This is an insidious fallacy, and we are not unlikely to fall into it in one form when we have escaped it in another; the mistake of supposing the mathematical probability could be confirmed by actual observation belongs to the head. The attempt to regulate betting by mathematical probability is another instance of the fallacy of confusing the subjective with the objective. The truth is that an observed average may be made the basis of a mathematical "probability" or modulus of evidence, by a process which could easily be explained; but though a "probability" may be based on an average, an average can never be based on a "probability." J. COOK WILSON.

Instruments of Precision at the Paris Exhibition.

I WAS glad to see your appreciative article upon the German instruments of precision at the Paris Exhibition, in which you refer, among other things, to the splendid catalogue which was freely given away to any one who showed any interest and desired to have a copy.

As a member of the Jury of Class 15, I naturally was led to duly appreciate both the German productions and their catalogue, and fearing that this valuable record might too soon become inaccessible, I asked Dr. Drosten if he would send a copy to the Science Library of the Victoria and Albert Museum, so that it might be permanently available for many who might wish to see it. This he most willingly did.

If copies are becoming scarce, it would be more to the point that public libraries attached to scientific institutions should have them than that they should run the risk of being buried and lost in private hands. C. V. BOYS.

A New Form of Coherer.

DURING the past eighteen months I have been called upon to demonstrate the principles of wireless telegraphy in connection with my regular lecture courses, and now and then, while wireless telegraphy was still the latest scientific novelty, in popular lectures.

For the latter purpose it was necessary to have the receiving apparatus as simple as was possible, compatible with a moderate sensibility and regularity of action.

I found the Marconi arrangement, consisting of the separate instruments, coherer, relay and decohering devices, to have the disadvantage, for my purpose at least, of requiring long and careful adjustment each time the apparatus was set up.

It occurred to me that if the functions of the three instruments could be performed by a single instrument, an easier adjustment would result.

This would, perhaps, be of no advantage in the case of a permanent set up, but would be of considerable advantage in apparatus designed for the purpose of demonstration.

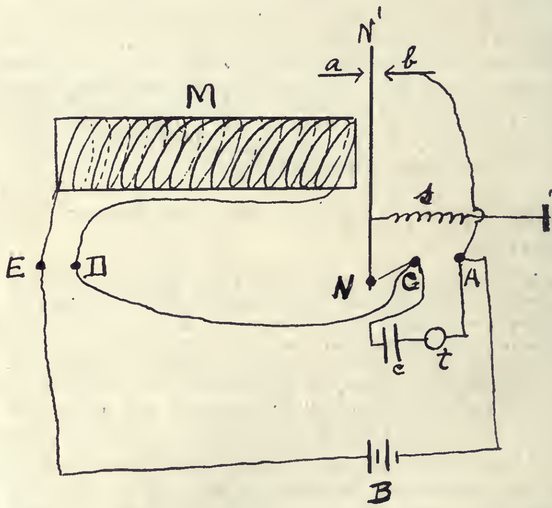
By a slight modification, which need not be permanent, an ordinary telegraph relay of moderate sensibility may be made to serve the purpose of the coherer, relay and decoherer of the Marconi arrangement.

The ordinary telegraph relay is shown in the accompanying sketch.

M is the electromagnet, which in most cases is mounted so that its distance from the armature, NN′, can be varied by a slow-motion screw, E and D are the main circuit terminals, A and C the terminals of the relay circuit, C is connected with the armature NN′, and A is connected to the stop *a* when the instrument is used as a relay. T is a screw connected to NN′ by a spiral by means of which the pressure of the armature on the stop *b* may be varied.

Usually the stop *b* is of hard rubber, and *a* and *b* may be interchanged. If this interchange is made and if C is connected with D, then the battery B will send a current through the electromagnet M and the loose contact N′*b*.

The tension in the spiral, *s*, and the position of the electromagnet may be adjusted so that no current flows, on account of the very high resistance of the loose contact (coherer) N′*b*. If this resistance is lowered by electromagnetic radiations, then the



current through the electromagnet rises and NN′ is attracted towards M and the circuit at N′*b* is broken. The spiral *s* draws NN′ back into contact with *b* and the instrument is ready to again respond to electromagnetic radiations. The adjustment of M and T are easily made, and once made the coherer works very steadily.

The motion of NN′ is too slight to be visible or to close an auxiliary circuit with a sounder, but if a telephone, *t*, in series with a condenser, *c*, is put in parallel with the coherer (*i.e.* across A C) the make and break of N′*b* are clearly audible.

If a "loud-speaking" telephone or a telephone with a manometric flame are used, the make and break can be made audible or visible to an audience.

If the distance between sending and receiving stations should make it necessary, C can be earthed and A connected with a vertical wire. It is well to have the resistance of the electromagnet as low as is compatible with moderate sensibility in order that the normal high resistance of the coherer shall form the major part of the total resistance in series with the battery.

In adjusting the contact N′*b* it is convenient to set M and T so that the armature NN′ vibrates automatically, and then relieve the tension in the spiral *s* until the automatic vibration just ceases.

When this adjustment is made, a "dot" signal from the sending station gives a single "tick" in the telephone—a dash gives a series of ticks.

I have never attempted to telegraph over a distance exceeding

several hundred feet, using the form of coherer described, and, therefore, I am unable to compare its sensibility with that of the usual form.

Undoubtedly it would prove to be less sensitive, but for use over a moderate distance it forms a convenient instrument for the purpose of demonstration. AUGUSTUS TROWBRIDGE.

University of Wisconsin, U.S.A.

Secondary Sexual Characters and the Coloration of the Prong-buck.

THE weak spot in Mr. Cunningham's argument (NATURE, November 8, p. 29) lies in his believing it to be conceded that secondary sexual characters which are the outcome of male katabolism need no explanation by the theory of sexual or of natural selection. Starting with this assumption, he points out that, since these characters are often not developed, male katabolism does not exist in such cases, or exists without producing any visible effects. He therefore rejects male katabolism as the cause of the variations and introduces in its stead "nervous and muscular activity" and "the habits of life and external conditions.

Whether Mr. Cunningham's hypothesis is an improvement upon that of Geddes and Thomson or Wallace may be doubted; and, so far as his views are intelligible to me from the brief epitome his letter contains, they labour under the disadvantage of involving an acceptance in the Lamarckian doctrine and the transmission of acquired characters—problems which, seductive and important though they be, are as yet insufficiently supported by evidence and, whether true or false, stand aside from the Darwinian theory, neither refuting nor confirming it.

After all, "male katabolism," "metabolism" and "physiological activities" are in this connection merely names assigned to the unknown primary cause of certain male characters, and, as such, are nothing but imposing substitutes for the "vital force" of the pseudoscientific realists.

Setting on one side the question of the initial cause of variation, I am quite unable to agree with Mr. Cunningham that secondary sexual characters may reach a high standard of perfection and be maintained in a state of stability by "physiological processes" without the controlling influences involved in the struggle for existence. Sexual variations, once started, must fall, like other variations, under the influence of external conditions; those which are harmful will be eliminated; those which are beneficial selected and preserved. Therefore, considering the diversity of the conditions under which species live, the needs that have to be satisfied, the enemies that have to be avoided, it is no matter for surprise that, even in the males of closely allied forms, the sexual characters vary in degree of manifestation, are sometimes suppressed, sometimes developed; or, taking the particular case Mr. Cunningham mentions, that the nigrescence of the bull kudu and nilghaie may, as I have suggested, be checked for purposes of concealment in the one and emphasised as an ornament or advertisement in the other.

One or two points in Mr. Cockerell's criticism of a footnote (NATURE, October 15, p. 58) call for comment. His suggestion that Mr. Wallace cites the prong-buck as an instance of recognition-marks in the sense in which these terms were employed in my article is inexact; and his opinion that I completely overlooked the point of a theory I was not discussing is, I can assure him, erroneous. Moreover, in spite of his incredulity, I venture to repeat that the prong-buck, with its white belly and darker upper side, *is* an illustration of Thayer's principle. That its patterns are to be explained exclusively on this principle I did not assert. With regard to Mr. Cockerell's reasons for rejecting the view that the prong-buck is procryptically coloured, I would commend the following facts to his consideration. Zebras and giraffes can be "seen from afar off in herds," they seek "safety in flight," and they have the same "necessity for keeping together when in flight" that the prong-bucks have. Nevertheless, these animals are known to be procryptically coloured, though the fact is by no means always evident to those who "have had the pleasure of seeing them in their native wilds." R. I. POCOCK.

November 18.

A New Race of Musk-Ox.

MR. ROWLAND WARD has on view at his establishment in Piccadilly a mounted adult male and female musk-ox from East Greenland, which differ from the ordinary form in having a large whitish patch on the face, as well as in certain other details of coloration. They may be made the types of a new race, under the name *Ovibos moschatus wardi*. The female was recently exhibited at the Zoological Society. R. LYDEKKER.

Harpenden, December 10.

The Optics of Acuteness of Sight.

IN reference to the letter of Mr. Percival in your issue of November 22 (p. 82), concerning acuteness of vision, it is interesting to determine the power of resolution of the eye considered as a lens merely, according to the well-known rule,

$$\theta=\frac{\lambda}{A}\times 2{\cdot}44.$$

Where θ is the angular diameter subtended at the second nodal point by the first dark ring of the diffraction image of a distant point, A is the aperture of the lens, and λ is the wavelength of the radiations (supposed homogeneous) from the distant point.

Taking A for the eye as 4 mm., and λ as 0·000589 mm. (yellow light) the value $\theta = 1{\cdot}2'$ is obtained.

Hence the diffraction image of a luminous point on the retina may be taken as rather less than 1′ in angular diameter (the brightness of the diffraction disc rapidly decreasing towards the first dark ring).

It would thus seem that, should any *considerable* superiority of acuteness of vision exist among savages the cause should be looked for in the aperture of the iris, as well as in greater detail of the retina. F. TWYMAN.

54, Haverstock Hill, London, N.W., November 26.

Euclid i. 32 Corr.

WITH reference to Mr. Allman's letter in NATURE of November 29, the following will, I think, be of interest.

In Proclus' (411–485 A.D.) commentary printed at the end of the Editio Princeps of Euclid (Grynaeus-Bâle, 1533 A.D.) these two corollaries are given:—

(1) The sum of the interior angles of any polygon is equal to twice as many right angles as the polygon has sides less two.

(2) The sum of the exterior angles of any polygon is equal to four right angles. STAM. EUMORFOPOULOS.

33, Gloucester Square, Hyde Park, W., December 3.

A PLEA FOR THE STUDY OF THE NATIVE RACES IN SOUTH AFRICA.

IN a recently-published work Dr. P. Topinard makes the statement that ethnography is cultivated in England because it leads to a knowledge of the natives, and thus prepares the means of turning them to account. This distinguished French anthropologist appears to have permitted his dispassionate judgment to have temporarily forsaken him. Alas! ethnography is but little cultivated in this country, and it may be said to be almost entirely neglected by our Government. It was to take away this reproach in some measure, and to seize the present opportunity in South Africa, that led Mr. E. Sidney Hartland, the President of the Folklore Society, to read before the Anthropological Section of the British Association at Bradford a very carefully considered and temperate paper, "On the Imperfection of our Knowledge of the Black Races of the Transvaal and Orange River Colonies."

Mr. Hartland stated that on the pacification of these colonies one of the first problems confronting us would be the management of the native black population. This led to the question, What did we know of the African races of these provinces? It must be confessed that we knew very little. Our hunters had hunted big game through the land; our missionaries had taught the natives; our traders had traded with black and white; our soldiers had fought in the country, and during the last twenty years mining adventurers had exploited the mineral products. None of these, except the missionaries, had had any real interest in the natives; consequently, few of the others had recorded anything of value

concerning them. The records by the missionaries had been for the most part scrappy, and, from a scientific point of view, not to be implicitly trusted. But the blame for this did not rest entirely on the missionaries. The gap which the missionaries found between the savage mind and their own was unexpectedly wide, and this rendered it difficult for them to understand the natives, as well as for the natives to understand them. Moreover, what the missionary learnt of the native manners and customs he did not think it becoming to publish. Moffat had said that a description of these things would not be instructive or edifying. In the interests of science and government, it was much to be regretted that he and other missionaries had taken this view. Later missionaries had given us more information; John Mackenzie and Livingstone's books contained much of value, but were incomplete, and not always exact. One other reason of our defective knowledge of the customs of the black people was that, until the country was settled by the Boers, there was a state of intermittent warfare, which frequently resulted in the extermination of whole tribes.

There was among the various tribes a general similarity of institutions, customs and belief, but this similarity was by no means uniform. In the Umzimkulu district of Kaffraria all additions to, and alterations of, laws were made by the chief and councils at Great Place. Among the Galekas, Fingoes and Basutos, laws could be altered after the fashion familiar to us in England as "Judge-made law." Conservative as the natives were, the fact that there were recognised ways of making changes implied that such changes were effected, and that differences existed. In the matter of theft the punishments inflicted varied among the different tribes. Property stolen from the chief was punished more severely; in Bechuanaland restitution was required to be made. It was also pointed out that there were difficult questions respecting marriage and inheritance. The prohibited degrees seemed to be in one direction much wider than with us. In general throughout South Africa all blood relationship, which was recognised as such, was an absolute bar to marriage. Among one tribe such a marriage was dissolved, and a heavy penalty inflicted on the man. Among another tribe the only question was how much the man was willing to pay. Some tribes permitted a man to be married to two sisters, both living. Most of the tribes were polygamists. This fact rendered family arrangements very complex, and most of the questions coming before the courts were questions of inheritance. Wives of a native polygamist were not equal in rank. There was a great wife and a right hand wife, and most of the tribes recognised a left hand wife. Among few tribes could a woman inherit property. The Basutos were among the few. In general women, though not themselves property, were in a state of tutelage, and so incapable of either holding or inheriting property. It was easy to understand that the large number of tribes in South Africa would furnish an interminable example of difference of custom. Cases of theft often came before the courts; in some districts cases of inheritance were very common; while cases relating to marriage were always important, because status and inheritance depended on marriage, and such questions were frequent subjects of judicial decision.

One of the modes of oppression of natives in the Transvaal, Mr. Hartland proceeded to observe, had been the refusal to recognise any of their marriages. This was a policy we should be compelled to reverse. In order to do so we must start by informing ourselves what marriages were regarded by the natives of each tribe as legal, lest in our hasty zeal for justice we inflicted injustice. This information could only be obtained by careful inquiry on the spot. A bride-price was usually paid for the bride, but it was not always given. In nearly all tribes, however, it was a necessary incident of the most honourable form of marriage. A bride for whom no price had been paid felt very much as in this country a strict Churchwoman would feel if she were forced to be married at a registrar's office. A wife for whom no price had been paid would be reminded of the fact every time she quarrelled with her neighbours or with one of her fellow-wives, or even with her husband. Twenty years ago the Cape Government came to the conclusion that it ought, both for legislative and administrative purposes, to learn something about the native customs and institutions. The report of that Commission was perhaps the most valuable document we possessed on the black races of South Africa, and must form the basis of any inquiry our Government might make into the customs of the native races of the Transvaal and the Orange River Colony. One of the difficult problems discussed by the Commission was that of the bride-price, known as *Lobola* or *Ukulobola*, and the question was whether the transaction was a bargain and sale of the bride, and, therefore, according to our law, immoral, or, if not, what it was? A Church missionary of twenty-three years' experience described it as being the "direct sale of the girl in its purest state," and a Wesleyan minister said it was the "root of heathenism." On the other hand, Archdeacon Waters and Dr. Calloway, Bishop of St. John's, had, however, expressed their opinion in favour of the custom, holding that the payment was a pledge for the good treatment of the woman, and a pledge of her good conduct.

It was established by the Commission that the custom of *lobola* was not a purchase of the bride, but a substantial guarantee for her good conduct and good treatment. But the inquiry showed that Europeans, even if experienced in native ways, were often incapable, from prejudice or ignorance, of penetrating below the surface to the real meaning of a custom. Some who gave evidence could not distinguish between slavery and tutelage, and in their view every Roman matron would have been a slave.

It must be remembered that we could not civilise the savage all at once, and with a veneer of civilisation he would be more dangerous than before, for he would accept only its sweets and reject its bitters. The subject of beliefs was not less important than that of customs. We ought to govern the native races according to their own laws, and not by ours. We should remember that if we had so much difficulty in understanding their laws, it was no wonder they had similar difficulty in understanding ours. They were, as a missionary told the Commission, so much attached to their customs, and their customs were so much a part of themselves, that they could not imagine any others. An accurate study of the native customs, institutions and beliefs was an urgent necessity both for missionaries and for purposes of government.

Now that the natives had come under British rule the opportunity ought to be taken to register their condition at the time, not less for scientific than for administrative reasons. The happiness of the natives depended on the way we treated them, and if we were ever to raise them to civilisation—which it must be the great object of every civilised Government to do—we must bear in mind that that could only be done gradually, and by deferring, as far as practicable, to their prejudices, and leading them gently, but gradually, from savagery to that condition of life in which we found our happiness, and in which it was to be hoped they would find theirs.

It is to be hoped that Mr. Hartland's plea will not be ignored by Her Majesty's Government, but that as soon as the condition of the Transvaal and the Orange River Colony should permit, and prior to any legislation affecting the natives, a commission should be appointed to

inquire (*a*) into the customs and institutions of the natives of those States, and (*b*) into the relations between the natives and European settlers, with power to make recommendations for the purposes above referred to; such commission to consist, so far as possible, of persons familiar with native life in South Africa, and, in addition, of at least one person, unconnected with South Africa, of recognised eminence in the study of savage customs and superstitions in general. A. C. HADDON.

ZOOLOGY IN THE WEST INDIES.

WE called attention in our "Notes" of November 29 (NATURE, vol. lxiii. p. 112) to a rumour that the curator of the museum of the Institute of Jamaica, who for close upon six years has laboured with marked success, is about to relinquish his office in the spring; and the receipt of confirmatory evidence forces upon us a comment upon the situation. The gentleman in question was originally appointed in 1896 for a period of three years, which was renewed in 1899, and during the whole time he has been most assiduous in both the ordinary curatorial and the scientific duties of his office. Under his charge the collections have grown, and by the renewal of old exhibits, and the incorporation of new ones, with a thorough rearrangement of the whole, they have become so materially improved and attractive as to have merited the cordial approval of expert visitors from the home countries and the United States of America. In pure science he has done more; for, while his predecessors were largely content with the mere superficial study of insects, birds and molluscs, he, covering a wider field, has done admirable work in both zoology and anthropology—in the study of the resources of the surrounding sea and of the aboriginal remains on land. He has produced a series of memoirs on the indigenous sea-anemones and coral organisms, which rank high in contemporary zoological literature, and which, as will be evident from the brief *résumé* of his results, which we published in the afore-mentioned note, have done much to clear up a great deal that is perplexing in the study of these organisms. When it is added that the work has necessitated his journeying afield, and that the climatic conditions render research of the kind on modern lines especially difficult, his threatened removal becomes still more mysterious.

Necessity for retrenchment is the alleged cause of it, and by that we presume is meant desire for relief from taxation. If so, the action does not tally with the fact that but a few weeks ago we received, from an authoritative source, a request for advice upon a scheme based on the belief that it might be possible ere long to obtain laboratory accommodation for marine biological work in the Island, in connection with the erection of some hospital buildings in course of construction. The later intelligence which reaches us indicates a sudden change of front for which we desire explanation. To dispense with the services of a curator would be to waste the labours of years, and to bring into reproach an institution now becoming universally recognised as a centre of enlightenment and culture.

From reports to hand, a suspicion arises that the zoological work, as at present carried out under the auspices of the Institute, is not deemed sufficiently economic or adapted to the precise requirements of the island; and that the failure of a recent attempt, on the part of the Caribbean Sea Fisheries' Development Syndicate, to test the resources of certain shallows and banks in the neighbouring seas by means of trawls and long lines, may have had something to do with the situation. If this be so, we can only express our surprise, for both the area explored and the methods employed were wholly inadequate. Assuming the economic desire, we would point out that the curator of the Jamaica Museum has been by no means neglectful of that phase of his opportunities, and that having recently been commissioned to report upon the Edible Echinus or "sea-egg" of the Barbadoes, in his reply—an *interim* report, now in circulation—he wisely advocates the determination of its life-history and recourse to artificial propagation and restocking.

Assuming that mere impecuniosity is the real cause of the trouble, we would recommend an appeal to the Home Government and the Colonial Secretary for immediate relief; and the advisability of an affiliation of the establishment with either the recently founded Imperial Agricultural Department, of which the headquarters are at the Barbadoes, or with some other existing institution of an authoritative kind. The time has passed at which work in marine zoology can longer be left to the caprice of mere local administration, and persons content only with an immediate *quid pro quo*. Experience shows that the scant success which has attended some of the marine zoological work of the past has been due to lack of coordination in observation. What we require for the future, and to ensure that success which even the economist desires, is more, and not fewer, marine observatories, and that these shall be so placed that collective work, properly coordinated, shall be possible over wide areas. Not until every colony having a sea-board, and till at appropriate points round every coast-line there shall be employed a marine zoologist who is a fishery expert, and who shall be provided with a laboratory, a steamboat, a full set of apparatus, and, if possible, a couple of trained assistants, can the desired result be hoped for. We want, and must have, marine stations at all desirable places, and to discourage one already in the making and doing good work is but to court failure and lessen the only chance of success.

As for the Colonies and their marine zoological and museum work, we would fain see the several existing establishments devoted to these placed under the advisorship of the authorities of the British Museum of Natural History, in the manner in which those in botany have so long been under the guidance of the officials at Kew, subject to their power of appeal to the Home Government; and we feel assured that were this already the case the action we herein deplore would never have come about.

Nearly eight years ago zoologists at home, headed by Huxley, directed attention to the resources of the West Indian seas and the pressing necessity for their investigation; and the work which has emanated from the museum of the Jamaica Institute has largely realised their expectations. The curator of that museum, moreover, during the period he has held office, has cultivated a healthy alliance with the authorities of the Johns Hopkins University and the members of its Biological School, foremost among marine zoologists of the North Atlantic, and this has already been productive of mutual gain and cooperative work in the intervening ocean. We now know that materials of prime importance abound in the Jamaica sea, and in the curator of the Jamaica Museum there lives a man, now familiar with these, competent to investigate with advantage both their scientific and economic aspects. His work, upon which we have commented, has been performed with the fullest sympathy and support of the Board of Governors of the institution. His retirement would be followed by their resignation, and chaos would ensue. The proposal to abandon the curatorship of the museum of the Jamaica Institute is retrogade, and it must not be if we, the proud colonisers of the world, are to retain our prestige.

NOTES.

The retirement of Mr. Charles Whitehead from the position of the Technical Adviser to the Board of Agriculture has led to a reconsideration of the means by which the Board obtain technical advice on questions relating to agricultural botany and economic zoology, and it has now been arranged that the scientific and expert assistance required by the Board in connection with these subjects will be furnished respectively by the Royal Botanic Gardens, Kew, and by the Natural History Departments, South Kensington.

The Paris correspondent of the *Times* states that at the sitting of the Academy of Sciences on Monday M. Becquerel, whose father and grandfather were also men of science, was warmly congratulated on having received the Rumford medal of the Royal Society. The Academy also elected, by forty-six votes to ten, M. Painlevé in the section of geometry to the seat left vacant by M. Darboux.

Dr. Allan Macfadyen, director of the Jenner Institute, has been elected Fullerian professor of physiology at the Royal Institution.

By a decision of the House of Lords, the Institution of Civil Engineers has been exempted from payment of the Corporation Tax (1894). In view of this fact it is submitted that the Royal Colleges of Physicians in London and Edinburgh may reasonably claim similar treatment; and we learn from the political notes in the *Times* that an attempt is being made by Sir John Tuke to induce the Chancellor of the Exchequer to concur in this view. The especial hardship in this case is that, notwithstanding the important part played by the two colleges in administering and regulating medical education and examination, and in maintaining laboratories for original research, and the obligation upon each Fellow to pay a stamp duty of 25*l.* on election, there will be five years of arrears to make up if the authorities persist in their intention to levy the tax.

The following are among the lecture arrangements at the Royal Institution, before Easter:—Sir Robert Ball, six lectures (adapted to young people) on great chapters from the book of nature; Prof. J. A. Ewing, six lectures on practical mechanics (experimentally treated); Dr. Allan Macfadyen, four lectures on the cell as the unit of life; Dr. Arthur Willey, three lectures on the origin of vertebrate animals; the Right Hon. Lord Rayleigh, six lectures on sound and vibrations. The Friday Evening Meetings will begin on January 18, when a discourse will be delivered by Prof. Dewar on gases at the beginning and end of the century. Succeeding discourses will probably be given by Prof. G. H. Bryan, Prof. J. J. Thomson, Sir W. Roberts-Austen, Mr. W. A. Shenstone, Dr. Horace Brown, and others.

Twenty-three papers, several of them of a highly important character, were read at a meeting of the U.S. National Academy of Sciences, held at Brown University, on November 13–14. Among novel subjects of general scientific interest brought before the meeting we notice the following:—An account of the study of growing crystals by instantaneous microphotography, by Prof. T. W. Richards; stereographic projection and some of its possibilities from a graphical standpoint, by Prof. S. L. Penfield; report of progress made with the Echelon spectroscope, and the spectrum of sodium in a magnetic field, by A. A. Michelson; the explanation of inertia and gravitation by means of electrical phenomena, by Prof. H. A. Rowland; male preponderance (Androrhopy) in Lepidopterous insects, by A. S. Packard; exhibition of certain novel apparatus; a wave machine; an expansion lens; a recording system of two degrees of freedom; a tube showing coloured cloudy condensation, by Dr. C. Barus; recent observations of the planet Eros, by Prof. E. C. Pickering.

Some valuable additions have recently been made to the equipment of the observatory of Salò, in Lombardy. They include several recording meteorological instruments, different forms of seismoscopes, a great seismometrograph, and a limnograph for registering the seiches in Lake Gardo, the observatory being situated on its western shore.

A double explosion, resulting in the loss of three lives, occurred on November 28 at the Smokeless Powder Works at Trimley, near Ipswich; the first in the mixing house, where 125 pounds of explosive material were being prepared, and the second in the drying house, which contained a large quantity of gun-cotton. The entire factory, consisting of a series of isolated sheds and a boiler house, was almost razed to the ground, the *débris* being scattered over the adjoining fields. The concussion was felt at Ipswich and Rendlesham House, near Wickham Market, which are about eight and twelve miles respectively from the scene of the disaster, and also, it is said, at other places outside a radius of fifteen miles.

The seismological observatory of Quarto-Castello, near Florence, is one of the most completely furnished so far as regards apparatus provided with mechanical means of registration (see Nature, vol. lxii., p. 200). Several instruments have been added during the past year, and the older ones have received some improvements in detail. Mr. D. R. Stiattesi, the director of the observatory, has just printed his second seismographic bulletin, that for the year November 1, 1899, to October 31, 1900. This valuable pamphlet contains details of the records by the different instruments of no fewer than 135 earthquakes. Its publication within a month of the date of the last entry is a feature worthy of imitation. Dr. G. Pacher has also issued the second part of the seismographic bulletin of the University of Padua for March 19 to June 30, 1899. The records at this observatory are obtained by means of the microseismographs designed by Prof. G. Vicentini, more than half (sixteen out of twenty-nine) being those which are characteristic of distant shocks.

In our Norwegian contemporary, *Naturen*, published in Bergen, Dr. Hans Reusch, director of the Geological Survey, notices some geological investigations of great interest which have been made by a young scientific Icelander, Mr. Helgi Pjetursson. According to this observer, Iceland shows that the Glacial period has had several subdivisions separated from each other by ice-free periods, as has been demonstrated to be the case in the Alps and other similar regions.

Dr. Reusch draws attention in *Naturen* to the changes of level that have taken place in Iceland in recent geological times, viz., since the Ice age. He points out that on a hydrographic map of the North Atlantic Ocean there is shown a submarine ridge under shallow water, which stretches from the Faroe Isles to Iceland and thence over to Greenland. North and north-east of it lies the deep Norwegian Sea. During the Norwegian Atlantic expedition there were found, strewed over the bottom, shells of Arctic mollusca, which at present live in a considerably colder climate and in much shallower water than that which prevails in the Norwegian Sea. Mr. H. Friele directed attention to that fact, and he suggested that the shells had been carried out to the deep sea by drifting ice. It ought, at the same time, to be remembered that Prof. G. O. Sars had found, off the Romsdal coast, in very deep water, shallow water shells and rolled pebbles, and he inferred that this was evidence that sinking of the sea-bottom had taken place there. In 1896 the Danish Ingolf Expedition investigated the sea-bottom between Ian Mayen and Iceland. In examining the dredged material, Herr A. S. Iensen made the observation that almost everywhere over the bottom of the deep ocean lie shells of dead molluscs of well-known

shallow water forms side by side with deep water forms. It was very remarkable to dredge up, from depths of 500 to 1300 fathoms, *Yoldia arctica*, which now lives at Spitsbergen and in the Kara Sea at depths from 5 to 100 fathoms. Dr. Reusch suggests that these remains of Arctic life-forms cannot have been carried there by drifting ice, but that the sea-bottom, in comparatively recent times, during the Ice age, must have been much nearer the sea-level than now. At that time the Arctic shallow water forms must have lived there *in situ*, then a sinking of the sea-bottom has taken place which can be estimated at not less than about 2500 metres. It is easy to see that these results of the Danish naturalist have an important bearing upon the phenomena of the Ice age.

ELECTRO-CHEMICAL sciences and industries will shortly have their own technical journal. The *Electro-Chemist and Metallurgist* will make its appearance on January 15, 1901, and will do its best to keep chemists and manufacturers informed as to the progress of knowledge of electro-chemistry and practical developments. The journal will be published monthly by Messrs. Sherard Cowper-Coles and Co., Ltd., Westminster.

A MONTHLY record of the progress of anthropological science is about to be established by the Anthropological Institute, and will appear under the title of *Man*. Its contents will include contributions to physical anthropology, ethnography and psychology; the study of language, and the earlier stages of civilisation, industry and art; and the history of social institutions and of moral and religious ideas. These various branches of study will be treated more fully, in proportion as they are less adequately provided for in existing periodicals. Special note will be taken, throughout, of investigations which deal with the origins and the earlier stages of those forms of civilisation which have eventually become dominant, and of the races among which they have arisen and developed.

AT a meeting of the Scientific Committee of the Royal Horticultural Society, on December 4, a curious "Weeping Chrysanthemum" was shown. The plant was one of eleven seedlings from a cross raised by Mr. Austen, Ditting Court, Maidstone. The peculiarity of all eleven plants consisted in the downward geotropic direction of the branches, which were bent like those of a Weeping Ash, but upturned heliotropically at the ends, where flowers are produced. Dr. Masters showed a drawing of seedlings of Leucodendron raised by him and presenting a curious outgrowth from the caulicle (hypocotyl), similar to that in the Pea.

THE U.S. *Monthly Weather Review* for July last contains an interesting article on fog studies on Mount Tamalpais, a little to the north of San Francisco, by Mr. A. G. McAdie. The paper is accompanied by photographic illustrations of (1) fog over the Golden Gate, taken from the Weather Bureau Observatory on the above mountain; (2) fog streaming in from the Pacific; and (3) valley fog, originally sea fog, but augmented by radiation about sunset. The locality is well chosen for the study of the formation of fog; from May until September, during which time scarcely any rain falls, great banks of fog invade San Francisco with clock-like regularity every afternoon, while it is known that at some 1500 feet above the air is clear, and 20° or 30° warmer. The mean relative humidity on the mountain is 59 per cent., while at San Francisco it is 83 per cent. It is worthy of note that during the summer of 1899 a difference of temperature of 44° was recorded within so short a distance as 25 miles between Mount Tamalpais (the warmer station) and Point Reyes. The Weather Bureau maintains a regular fog service at San Francisco, and the extent and character of the fog in the roadstead and neighbouring localities are made known by means of frequent reports.

WE have received a copy of the Report of the Meteorological Commission of the Cape of Good Hope for the year 1899. There have been in operation during the year (or some part of it) about 450 stations, including the observatories at the Cape and at Kenilworth, near Kimberley; of this number 364 stations observe rainfall only. About 23 per cent. of the returns are incomplete, owing chiefly to the effects of the war. The observer at Kenilworth (Mr. Sutton) continued his observations all through the siege of Kimberley, although this station was situated outside the lines of defence, and, owing to his courage, the important records for the year are unbroken. It has been found that the old pattern Stevenson thermometer screen formerly used in this country does not sufficiently protect the instruments from the intense radiation in that part of the world, and that, except during strong winds, any two spots inside the screen seldom had the same temperature. The screen adopted is an enlarged one, designed by Mr. C. L. Wragge; it is, like the new pattern Stevenson screen, provided with a double roof, with three overlapping boards in the base of the screen, and it appears to be much better adapted to the conditions prevailing in South Africa. Some interesting notes from the Report of inspection of the stations are given by Mr. C. Stewart, Secretary to the Commission.

IN the annual report of the Imperial Bacteriologist of India (Mr. Lingard) for 1899–1900, we regret to learn that a large portion of the valuable laboratory specimens, records and library was destroyed by fire last year. An outbreak of a disease clinically resembling glanders, but differing from the latter (*a*) in not reacting with mallein, and (*b*) in the absence of the *Bacillus mallei*, is described and identified as "lymphangitis epizootica" of Rivolta, due to a protozoon parasite. The greater portion of the report deals with experiments conducted with regard to rinderpest. Animals vaccinated by injections of blood and of bile of diseased beasts were found to be fully protected nearly two years after the inoculations. Animals may be inoculated with increasing amounts of virulent blood, and then yield a serum which will protect against rinderpest, and a rapid method of immunising is described. The immunity produced by an injection of serum is, however, transient; and in order to produce a lasting or "active" immunity, recourse must be had to inoculation with virulent blood. But this is a risky operation, a considerable proportion of the beasts so inoculated dying; and, in order to avoid this, a preliminary injection of the immunising serum is given followed by the virulent blood. The amount of the serum used must be small, sufficient to ward off serious symptoms but not to prevent a transient illness; otherwise the immunity would be "passive," and not a lasting one.

A NOTABLE instance of "discontinuous distribution" is recorded by Prof. W. M. Wheeler in the *American Naturalist* for November. It appears that in 1886 a very remarkable and aberrant arachnid was described from Sicily under the name of *Koenenia mirabilis*; this creature showing a superficial resemblance to the whip-scorpions, although representing an entirely distinct group by itself. During the past spring Prof. Wheeler collected in Texas an arachnid which, on examination, proved to be specifically identical with the Sicilian form. In Sicily, Koenenia was found in association with species of the genera Japyx, Campodea, Scolopendra, and Pauropus; and, with the exception of the last, it occurs in Texas in company with representatives of the same genera. The European and American species of these genera are, however, distinct. Prof. Wheeler cannot admit that the Koenenia was introduced, and he regards it as the survivor of a very ancient fauna. An analogous case is presented by the occurrence of *Proiapyx stylifer*, a primitive thysanurid insect, in Liberia and Argentina.

IN the *American Naturalist* Prof. Wheeler describes a new genus of insect living commensally with certain ants. The general reader will, however, be specially interested in the so-called "mushroom gardens" formed by the ants in question. It appears that they cut and transport into their subterranean cellars large pieces of leaves, which are there divided into smaller fragments, and ultimately reduced to a fine pulp. "This pulp is heaped up, and soon becomes invaded by the mycelium of a fungus. The mycelium is kept aseptically clean—*i.e.* free from all species of fungi and even from bacteria—and induced to grow in an abnormal way by bringing forth minute swellings which constitute the only food of the ant colony. Möller likens these swellings to the 'kohlrabi' of the German kitchen gardens."

THE U.S. Department of Agriculture has published a *Bulletin*, by Dr. L. O. Howard, describing the principal insects affecting the tobacco plant. Although indigenous to America, this plant does not suffer so severely from insect attacks as do many other crops in the United States. It has no insect enemies peculiar to itself, although every year a certain amount of damage is done to the crop, which in some seasons may assume serious proportions. Remedial agencies in the form of poisons can be easily applied to the seed-beds, while arsenical spray may be employed at a later stage. Much good can also be effected by means of various solanaceous plants, such as nightshade, horse-nettle, and Datura, growing in the neighbourhood of the crop. Small clumps of these can be left growing, which will attract the noxious insects while the tobacco is still young, such clumps being subsequently cut down and destroyed with the pests upon them.

THE Trustees of the Indian Museum have issued a "Guide to the Zoological Collections exhibited in the Bird Gallery," by Mr. F. Finn. The author is so well known as an authority on Indian birds that any contribution from his pen on the subject cannot fail to be of value. But he has departed from the usual practice of ornithologists by relegating the groups generally termed "orders" to the rank of "suborders," thereby rendering avian classification much more in harmony with that of other vertebrate classes. He also refrains from adding the superfluous affix "*formes*" to such subordinal groups. While in every respect admirably suited to the special purpose for which it is intended, this "Guide" has, therefore, a value considerably exceeding that attaching to the majority of publications of a similar nature.

WE have received Parts vii. and viii. of "Papers from the Harriman Alaska Expedition," now in course of publication in the *Proceedings* of the Washington Academy of Sciences. Both are from the pen of Mr. T. Kincaid, and deal with entomology. Although the collection of insects and arachnids is very large indeed, it indicates that, with the possible exception of the beetles, which were previously collected during the Russian occupation, scarcely a beginning has been made towards bringing to light the arthropod fauna of this vast region. Mr. Kincaid commences with an account of the insects known as Tenthredinoidea, of which he describes a number of new forms. His second communication deals with the metamorphoses of certain beetles.

IN an article on Lepidoptera in South Devonshire, which appears in the December issue of the *Entomologist*, Mr. J. Jäger states that he never saw the clouded yellow butterfly in such profusion as in the week following August 15. They were simply swarming in the clover fields and lanes, and were probably as numerous as in 1877. Two plates of hybrid moths illustrate the continuation of the account of experiments on cross-breeding by Prof. Max Standfuss in the same issue.

AMONG other papers, the November issue of the *Journal* of the Quekett Microscopical Club contains one by Mr. A. A. Merlin, on "Structural Division of the Endoderm in Bacilli of the Bubonic Plague," which ought to prove of considerable interest to students of that disease at the present time.

THE December number of the *Entomologist's Monthly Magazine* contains a communication from Baron C. R. v. d. Osten Sacken, in which it is pointed out that the proper title of the malaria-producing mosquito is *Anopheles maculipennis*, and not, as has been generally supposed, *A. claviger*.

THE distinctive peculiarities of the skull of the puma forms the subject of a note by Dr. A. Dugés in the last issue of the *Memorias y Revista* de la Sociedad Cientifica "Antonio Alzate."

THE Anthropological Society of Paris has just published an authors' and subject index of all publications issued by it since its foundation in 1860.

MESSRS. A. GALLENKAMP AND CO. have issued a bulky and comprehensive catalogue of chemical apparatus, balances and accessories of various kinds used in the teaching of chemistry and related subjects and in practical analysis. The catalogue is one which may with advantage be kept for reference by science demonstrators and teachers.

THE third edition, revised and enlarged, of "An Elementary Treatise on Dynamics, containing Applications to Thermodynamics," by Dr. B. Williamson, F.R.S., and Dr. F. A. Tarleton, has been published by Messrs. Longmans, Green and Co. The whole work has been revised and some portions of the subject have been developed, more especially that on generalised co-ordinates in connection with Lagrange's and Hamilton's methods. Students intending to devote serious attention to the study of dynamics will find the volume a helpful introduction to the great treatises of Thomson and Tait and of Routh.

AN elaborate "Report on the Census of Cuba," by Lieut.-Colonel J. P. Sanger (Director) and Messrs. H. Gannett and W. F. Willcox (Statistical Experts), has just been published by the U.S. War Department. The census was the first step taken towards the establishment of an effective system of self-government in the island, and as no census had previously been taken by the people the difficulties were numerous and great. To induce the Cubans to take a real interest in the census, it was decided that the work should be performed by them, under the supervision of an officer of the United States Census, and this was actually done, so that when the enumeration was completed it was a census of Cubans by Cubans. The total population of Cuba, including the Isle of Pines and the neighbouring islets, was 1,572,797 on October 16, 1899. At a census taken under Spanish authority in 1887, the population was returned as 1,631,687, and if this is assumed to be correct, the diminution during the twelve intervening years is about 3·6 per cent. The native whites constitute 57·8 per cent., or considerably more than one-half of the population of Cuba; the foreign white people constitute 9 per cent.; the coloured people 32 per cent., or about one-third; and the remainder are Chinese. Illustrations of typical Cuban people and buildings, and numerous maps are included in the report.

READERS of popular periodicals know that articles upon scientific topics appear in every number of *Pearson's Magazine*. The December number contains several contributions of this character. The Rev. H. N. Hutchinson describes some prehistoric animals and illustrates them with some good pictures. Special mention is made of the giant ground sloth of Patagonia, for a living representative of which Mr. H. Prichard is seeking, having been sent to Patagonia for this purpose by the *Daily Express*. A number of striking coloured portraits of American Indians, showing the devices painted upon their faces, as marks

of distinction, accompany an article by Mr. T. Dreiser. The marble quarries at Monte Sagro, in the vicinity of Carrara, are described and illustrated by Mr. E. St. John Hart. Two series of photographs of a cat and dog jumping over an obstacle are contributed by Mr. A. C. Banfield. Dr. See's views upon the mode of formation of stellar systems are expounded in another article. Mr. George Griffith describes the line where the day changes, near the 180th degree of longitude, making it the text of an article upon the places where the twentieth century will commence; and Mr. Walter Wellman describes some of his Arctic experiences. Six pretty photographs of birds are reproduced in the *English Illustrated Magazine.*

THE use of gas thermometers at high temperatures is the subject of an interesting paper by Messrs. Holborn and Day (*Wied. Ann.* 68, 817). Experiments with porcelain vessels, glazed and unglazed, have shown that this material is unsuitable for the construction of the containing vessel, especially when the gas used is hydrogen. Platinum iridium vessels (10 or 20 per cent. Ir) containing nitrogen appear to be very trustworthy; after the thermometer has been heated to 1100° C. for a considerable time, the indications of the instrument at low temperatures remain unaltered. The thermo-elements usually employed for the measurement of high temperatures have been carefully compared with this gas thermometer, and the electromotive force represented as a quadratic function of the temperature. With these thermo-elements the melting-points of a series of metals have been determined, so that the calibration and control of other elements is made independent of the standard nitrogen thermometer. The authors claim that the error in the determination of high temperatures (up to 1150° C.) does not exceed 1° C. The influence of air on the melting-points of copper and silver is interesting, as is evident from the following numbers—copper (pure) 1084·1° C., (in air) 1064·9° C.; silver (pure) 961·5° C., (in air) 955° C.

WE learn from the Marine Biological Laboratory at Plymouth that a male specimen of *Squilla desmarestii*, 2⅝ inches long, was brought in last week by a shrimper who had been trawling inside Plymouth Breakwater. The rarity of this Stomatopod in Devonshire waters is shown by the fact that this is only the second specimen that has been taken at Plymouth since the laboratory opened in 1888, the other, a small one ½-inch long, having been taken in the tow-net about three years ago.

THE additions to the Zoological Society's Gardens during the past week include two Puff Adders (*Bitis arietans*), a Yellow Cobra (*Naia flava*), two Delalande's Lizards (*Nucras delalandii*), thirty-two Spotted Slow Skinks (*Acontias meleagris*), three Rough-keeled Snakes (*Dasypeltis scabra*) three Smooth-bellied Snakes (*Homalosoma lutrix*), three Crossed Snakes (*Psammophis crucifer*), five Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), two Coppery Snakes (*Prosymna sundevalli*), a Lineated Snake (*Boodon lineatus*) from South Africa, presented by Mr. J. E. Matcham; six Yellow-legged Frogs (*Rappia horstockii*) from South Africa, presented by Mr. W. L. Sclater; a Black Rat (*Mus rattus*), British, presented by Mr. E. Wormold; two Bactrian Camels (*Camelus bactrianus*, ♂ ♀) from Siberia, a Moose (*Alces machlis*, ♂) from North America, two Ashy-black Macaques (*Macacus ocreatus*) from the East Indies, a Golden-headed Marmoset (*Midas chrysomelas*) from South-east Brazil, a Red-footed Lemur (*Lemur rufipes*) from Madagascar, a Rufous-necked Wallaby (*Macropus ruficollis*) from New South Wales, four Westerman's Eclectus (*Eclectus westermani*) from Moluccas, a Plain-coloured Amazon (*Chrysotis inornata*) from South America, a Mongolian Pheasant (*Phasianus mongolicus*, ♂) from Mongolia, a Blackbird (*Turdus merula*, pied. var.), European, deposited.

OUR ASTRONOMICAL COLUMN.

LOCAL CONDITIONS FOR OBSERVATION OF THE TOTAL SOLAR ECLIPSE, 1901, MAY 17–18.—A pamphlet has been received containing information for observing parties and summaries of the climatological conditions along the track of the moon's shadow during the total solar eclipse in May 1901. The work is the report of a committee of the society, Koninklijke Natuurkundige Vereeniging in Nederlandsch-Indië, appointed at the request of the Government at Batavia.

With the exception of Batavia, which is out of the eclipse track, there is no regular meteorological service in the Malay Archipelago. Regular observations of rainfall, however, have been made during the period 1879–1900 at about 220 different places. As this factor alone does not give sufficient evidence as to the suitability of a place for observation of a total solar eclipse at noon, special series of climatic data have been obtained during the months of April, May and June 1900, in several places well situated for the purpose.

Twenty-two stations have been selected, extending from Padang, on the west coast of Sumatra, to Amboyna and Saparua, at the eastern extremity of the Celebes group. Tables are given showing the cloudiness of the sky, mean rainfall, daily and hourly rainfall.

As regards general condition of sky during May, the west coast of Sumatra appears to have the worst reputation, the percentage clearness being only 28 per cent., as against 50 per cent. for the Macasar Sea between Borneo and Celebes.

As regards rainfall, the western stations are apparently the better, Padang averaging fifteen rainy days in May, while at Amboyna there are twenty-seven. The actual rainfall is little or no indication of weather condition, as excessive rains do not involve a period of clouded sky; on the contrary, the atmosphere is cleared from dust by heavy rains, so that in the rainy season the sky is much more transparent than during the dry season. Several suggestions with respect to the accommodation at the various localities may be useful to observers.

The most convenient stations will probably be on the west coast of Sumatra. *Padang* is the residence of the Governor, is in weekly communication with Europe, has a telegraph office and four hotels.

Painan is situated south of Padang on the sea shore; it has no harbour, but is easily reached by land from Trusan Bay, where there is good anchorage.

Solok, in the interior, at an elevation of 1300 feet above sea-level, has a telegraph office and small hotel, and is connected with Padang by rail.

Pulo Lalang, an islet of the Lingga group, lies close to the central line, and possesses good anchorage for small vessels, which could be hired at Singapore.

Pontianak, on the west coast of Borneo, is in direct communication with Singapore once or twice weekly. It has a small hotel. The soil is said to be very swampy and unsuitable for large instruments.

Macasar, the capital of Celebes, has a telegraph office and two hotels, and is in direct communication with Singapore once a week.

Amboyna and *Saparua* are only in communication once or twice a month unless with special service.

As soon as a station is selected, arrangements should be made for securing the support of the civil officials, application being made in the first instance to the Governors or Residents. For temporary establishments bamboo and other materials are obtainable on the spot, and are inexpensive. Skilful craftsmen are not available except in the principal places. Portland cement may be purchased at Padang, Batavia, Surabaya and Macasar. No Customs duties are levied on instruments in the Dutch Colonies.

"ANNUAIRE ASTRONOMIQUE, &C., FOR 1901."—This well-known little annual volume, which is compiled by M. Camille Flammarion, will be found as useful as ever for the coming year. One finds in it all the more important details and events of celestial phenomena. Thus, we are given the facts about the coming solar and lunar eclipses, the chief tables of the solar system, charts of the sky for each month, showing the paths and positions of the planets. Further, there are several short notices on such subjects as solar spots, atmospheric observations, the eclipse of 1900, meteor observations, terrestrial magnetism, meteorological tables, &c. As a handy *vade mecum* for those who possess and use small equatorials, this annual should be specially very welcome.

"THE HEAVENS AT A GLANCE," 1901.—This handy little publication (now in its fifth year of issue) is practically a card calendar devoted to astronomical particulars, and is designed to serve as a handy remembrancer as to the phenomena predicted for any period, any further details required being obtained from a more bulky volume of reference. Besides the daily phenomena of importance, monthly summaries of the aspects of constellations, sun's declination, moon's phases, and positions of planets are given. This occupies about half of the sheet. The remainder is devoted to a series of useful descriptive notes and statistics of various celestial objects, including special features on the moon's terminator during the lunation, elongations and oppositions of the planets, data for eclipses, meteor shower radiants, and the coordinates of a selection of the brightest stars. This card should be especially useful to amateurs who find the larger reference books too cumbersome. It may be obtained from the compiler, Mr. Arthur Mee, F.R.A.S., Tremynfa, Llanishen, near Cardiff.

"COMPANION TO THE OBSERVATORY" FOR 1901.—This useful contribution to the astronomer's library has recently been issued, and will doubtless be accorded its usual welcome. The contents, occupying 36 pages, have from experience been so condensed as to leave out no information likely to be wanted by the general worker that little or no alteration has been made in the arrangement. Beginning with particulars of the sun's times of rising, setting, its declination, mean and sidereal time, and phases of the moon for every week, there follows a calendar showing the times of rising, southing and setting of the moon, and the longitude of the terminator for each day of the year; a list of the principal radiant points of meteors, compiled by Mr. Denning; ephemerides for all the planets, including the minor planets Ceres, Pallas and Vesta; and times of elongation, stationary points, &c.; solar and lunar eclipses, occultations; phenomena of the satellites of Mars, Jupiter, Saturn, Uranus and Neptune; ephemeris containing data for physical observations of the sun; mean places of variable stars, with epochs of maxima and minima; particulars of 115 double stars.

ARGON AND ITS COMPANIONS.[1]

THE discovery of krypton and neon was announced to the Royal Society in the early summer of 1898; and subsequently atmospheric air was found to contain a heavier gas to which the name of xenon was applied. Mr. Baly, in the autumn of the same year, called attention to the presence of helium lines in the spectrum of neon, an observation which confirms that made by Prof. Kayser, of Bonn, and by Dr. Friedländer, of Berlin.

At the same time we imagined that we had obtained a gas with a spectrum differing from that of argon and yet of approximately the same density; to this gas we gave the name metargon. It has now been found that the presence of the so-called metargon is to be accounted for by the fact that in removing oxygen from the mixture of these gases, which was then in our hands, phosphorus containing carbon was employed; this mixture when burned in oxygen yields a spectrum to some extent identical with that furnished by carbon monoxide, but differing from it inasmuch as lines of cyanogen are also present. We have no doubt that the so-called metargon, the spectrum of which is visible only at high pressure, and only when impure phosphorus has been employed to remove oxygen, must be attributed to some carbon compound. In spite of numerous experiments we have not yet succeeded in producing any gas in quantity which yields this composite spectrum. It is only to be obtained by a mixture of carbon monoxide with cyanogen.

To obtain the heavier gases krypton and xenon, a large amount of air was allowed to evaporate quietly; the residue was freed from oxygen and nitrogen, and then consisted of a mixture of krypton, xenon and argon, the last forming by far the largest portion of the gas; this mixture was liquefied by causing it to flow into a bulb immersed in liquid air, and the bulk of the argon was removed as soon as the temperature rose, the krypton and the xenon being left behind. By many repetitions of this process we were finally successful in separating these three gases from each other. While krypton has a considerable vapour-pressure at the temperature of boiling air, the vapour-pressure of xenon is hardly appreciable, and this afforded a means of finally separating these two gases from one another; in the complete paper the operations necessary to separate them are fully described.

For neon the process of preparation was different. The air liquefier furnished a supply of liquid air; the gas escaping from the liquefier consisted largely of nitrogen; this mixture was liquefied in a bulb immersed in the liquid air which the machine was making. When the bulb had been filled with liquid nitrogen a current of air was blown through the liquid until some of the gas had evaporated. That gas was collected separately, and deprived of oxygen by passage over red-hot copper; it contained the main portion of the neon and the helium present in the air. The remainder of the nitrogen was added to the liquid air used for cooling the bulb in which the nitrogen was condensed. Having obtained a considerable quantity of this light nitrogen it was purified from that gas in the usual manner, and the argon containing helium and neon was liquefied. By fractional distillation it was possible to remove the greater portion of the helium and neon from this mixture of gases, leaving the argon behind. Many attempts were made to separate the helium from the neon. Among these was fractional solution in oxygen, followed by a systematic diffusion of the two gases; but it was not found possible to raise the density of the neon beyond the number 9·16, and its spectrum still showed helium lines. It was not until liquid hydrogen, made by an apparatus designed and built by one of us (M. W. T.), had been produced in quantity, that the separation was effected; the neon was liquefied or perhaps solidified at a temperature of boiling hydrogen, while the helium remained gaseous. A few fractionations serve to produce pure neon; we did not attempt to separate the helium in a pure state from this mixture.

That these are all monatomic gases was proved by determination of the ratio of their specific heats by Kundt's method; the physical properties which we have determined are the refractivities, the densities and the compressibilities at two temperatures, and of argon, krypton and xenon the vapour-pressures and the volumes of the liquids at their boiling points.

The results are as follows:—

	Helium.	Neon.	Argon.	Krypton.	Xenon.
Refractivities (Air = 1) ...	0·1238	0·2345	0·968	1·449	2·364
Densities of Gases (O = 16)	1·98	9·97	19·96	40·88	64
Boiling-points at 760 mm.	?	?	86·9° abs.	121·33° abs.	163·9° abs.
Critical temperatures ...	?	below 68° abs.	155·6° abs.	210·5° abs.	287·7° abs.
Critical pressures	?	?	40·2 metres	41·24 metres	43·5 metres
Vapour-pressure ratio ...	?	?	0·0350	0·0467	0·0675
Weight of 1 c.c. of liquid	?	?	1·212 grammes	2·155 grammes	3·52 grammes
Molecular volumes	?	?	32·92	37·84	36·40

The compressibilities of these gases also show interesting features. They were measured at two temperatures—11·2° and 237·3°; the value of P.V. for an ideal and perfect gas at 11·2° is 17,710 metre-cubic-centimetres, and at 237·3° to 31,800. This is, of course, on the assumption that the product remains constant whatever be the variation in pressure. Now with hydrogen at 11·2° C. the product increases with the rise of pressure; with nitrogen, according to Amagat, it first decreases slightly and then increases slightly. With helium the increase is more rapid than with hydrogen; with argon there is first a considerable decrease followed at very high pressures by a gentle increase, although the product does not reach the theoretical value at 100 atmospheres pressure; with krypton the change with rise of pressure is a still more marked decrease, and with xenon the decrease is very sudden. At the higher

[1] A paper by Prof. William Ramsay, F.R.S., and Dr. Morris W. Travers. Read at the Royal Society on November 15.

temperature the results are more difficult to interpret; while nitrogen maintains its nearly constant value for P.V., helium decreases rapidly, then increases, and the same peculiarity is to be remarked with the other gases, although they do not give the product of P.V. coinciding with that calculable by assuming that the increase of P.V. is proportional to the rise of absolute temperature.

These last experiments must be taken as merely preliminary; but they show that further research in this direction would be productive of interesting results.

The spectra of these gases have been accurately measured by Mr. E. C. C. Baly, with a Rowland's grating; the results of his measurements will shortly be published. It may be remarked, however, that the colour of a neon-tube is extremely brilliant and of an orange-pink hue; it resembles nothing so much as a flame; and it is characterised by a multitude of intense orange and yellow lines; that of krypton is pale violet; and that of xenon is sky-blue. The paper contains plates showing the most brilliant lines of the visible spectrum.

That the gases form a series in the periodic table, between that of fluorine and that of sodium, is proved by three lines of argument:—

(1) The ratio between their specific heats at constant pressure and constant volume is 1·66.

(2) If the densities be regarded as identical with the atomic weights, as in the case with diatomic gases such as hydrogen, oxygen and nitrogen, there is no place for these elements in the periodic table. The group of elements which includes them is:—

Hydrogen. 1	Helium. 4	Lithium. 7	Beryllium. 9
Fluorine. 18	Neon. 20	Sodium. 23	Magnesium. 24
Chlorine. 35·5	Argon. 40	Potassium. 39	Calcium. 40
Bromine. 80	Krypton. 82	Rubidium. 85	Strontium. 87
Iodine. 127	Xenon. 128	Cæsium. 133	Barium. 137

(For arguments in favour of placing hydrogen at the head of the fluorine group of elements, see Orme Masson, *Chem. News*, vol. lxxiii., 1896, p. 283).

(3) These elements exhibit gradations in properties such as refractive index, atomic volume, melting-point and boiling-point, which find a fitting place on diagrams showing such periodic relations. Some of these diagrams are reproduced in the original paper. Thus the refractive equivalents are found at the lower apices of the descending curves; the atomic volumes, on the ascending branches, in appropriate positions; and the melting- and boiling-points, like the refractivities, occupy positions at the lower apices.

Although, however, such regularity is to be noticed, similar to that which is found with other elements, we had entertained hopes that the simple nature of the molecules of the inactive gases might have thrown light on the puzzling incongruities of the periodic table. That hope has been disappointed. We have not been able to predict accurately any one of the properties of one of these gases from a knowledge of those of the others; an approximate guess is all that can be made. The conundrum of the periodic table has yet to be solved.

ACTION OF TERRESTRIAL MAGNETISM ON THE RATES OF CHRONOMETERS.

IN the issue of the *Comptes rendus* of the Paris Academy of Sciences for November 26, vol. cxxxi., pp. 859-865, there is an important communication by Prof. A. Cornu, dealing with an experimental investigation of the action of a terrestrial magnetic field on the rate of a magnetised chronometer.

The observations have been carried out on a pocket half-chronometer, provided with anchor-escapement, compensated balance and palladium spiral, whose rate had previously been very satisfactory, but which had inadvertently become magnetised by a large electro-magnet. The generally prevalent idea is that a magnetised watch is quite untrustworthy until it has been completely demagnetised, but the author's research has convinced him that there is evidence of a regular law in the rate of such an affected timepiece, and therefore it should be possible to neutralise the disturbance, either by tables of correction formulæ, or by suitably disposed compensators.

The magnetisable parts are the pivots, anchor, spring, balance-wheel and accessories to the escapement. In watches of precision all direct contacts between steel parts are avoided by the use of hard stone bearings, so that the mutual actions are inductive effects. If, then, the watch be laid on a horizontal table at a definite orientation, the only disturbing external force capable of affecting its rate will be the terrestrial magnetic field. To test this, provision was made for varying the orientation of the balance by making the horizontal support movable about a vertical axis, and then keeping the watch or clock for several days successively in the four positions corresponding to the hours XII, III, VI, IX, pointing respectively to the Magnetic North.

Systematic observations from 1898 June 20 to 1900 November 17, furnish a series of values for the variations in rate at the four orientations, and the discussion of them has enabled Prof. Cornu to show that they may be represented by a *sinusoid*. The magnetic state of the watch remains sensibly constant; the semi-amplitude of the variations with the orientation was 10·37 secs., and the mean azimuth of the ascending node of the sinusoid about 260° 21′. This result is especially interesting and important in that this sinusoidal law is identical with that obtaining when a watch having a balance wheel slightly out of equilibrium is hung with its dial vertical and oriented to different azimuths. That is, gravity also produces, if the mean amplitude remains constant, a couple proportional to the vertical projection of the eccentricity of the centre of gravity. Here a series of observations of the rate of the same watch before it was magnetised are given, taken during the period 1890 October 26–1891 January 25, showing the fulfilment of the sinusoid law in this respect.

It would thus appear that the condition discovered by Phillips (*Annales des Mines*, 6th series, vol. ix., p. 321, 1866) for eliminating the disturbance due to gravitation may also be applied to the compensation for magnetisation.

As a crucial test of the truth of his deductions, Prof. Cornu performed a substitution experiment in which the earth's magnetism was directly allowed for. In a piece of cork of exactly the same form as the watch a cylindrical hole was cut in the position corresponding to the balance wheel. In this was supported a small compass needle, and the whole supported on a horizontal table. By means of a jointed arm a bar magnet was held in such a position that the earth's magnetism was neutralised, leaving the needle astatic. This done, the watch was substituted for the cork, the orientation of the balance wheel being the same as the small compass in the cork. This substitution of cork model, getting astatic position by bar magnet, and replacement of watch, was repeated for the four orientations, and the daily rate carefully determined. It was found to be sensibly *constant in all positions*.

The paper concludes with the following summary:—

(1) Chronometers of precision are influenced by variations of the magnetic field in which they are placed to an amount depending on the degree of magnetisation of the balance wheel and spring.

(2) It is important to determine the magnetic moment of the balance wheel, mounted or not on the spiral.

(3) In observatories studying chronometer rates it is necessary to regularly determine the comparative variations in four rectangular azimuths for calculating the formulæ of correction.

(4) In all cases it should be the endeavour to attain an amplitude of 440° for the oscillations of the balance wheel, as recommended by Phillips, to eliminate the action of the terrestrial magnetic couples.

(5) For precaution, in observatories as well as on board ship, it would be well to envelop each chronometer with a thick box of iron, so that the relative action of the terrestrial field may be lessened.

C. P. B.

THE EFFECTS OF AN EARTHQUAKE ON HUMAN BEINGS.

CAPTAIN DUTTON'S valuable memoir on the Charleston earthquake of 1886 contains many accounts of the effects of this great earthquake on human beings. Nowhere could they be more vivid than in Charleston itself. "On every side," says one witness, "were hurrying forms of men and women, bareheaded, partially dressed, some almost nude [the earthquake

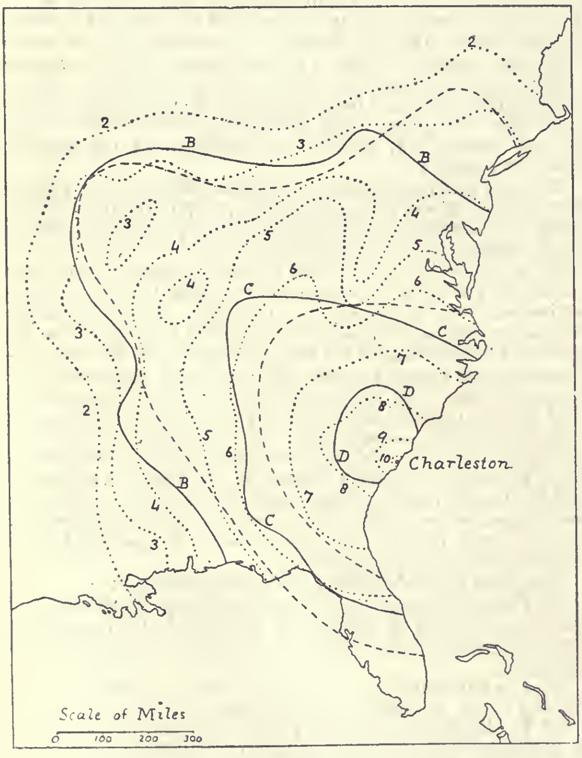
occurred at 9.51 p.m.], and all nearly crazed with fear and excitement. . . . A few steps away, under the gas-lamp, a woman lies prone and motionless on the pavement, with upturned face and outstretched limbs, and the crowd which has now gathered in the street passes her by, none pausing to see whether she is alive or dead . . . ; many voices are speaking at once, but few heed what is said." Between this, which must surely be almost the limit of wild fear in a crowd, and the merely interested curiosity of the most distant observers, there seems to be nearly every stage of mental effect recorded. Such terms as "greatest consternation," "fright and excitement unparalleled," and "terror amounting to wild frenzy," are, of course, too dependent on the narrator and too vague to be of any value as degrees in a scale of mental effects; but the resulting actions are less liable to error or exaggeration, and these may be roughly classified as follows, the different degrees being lettered to avoid confusion with the numbers of the soseismal lines:

(A) No persons leave their rooms.

(B) Some persons leave their houses.

(C) Most persons run into the streets, which are full of excited people.

(D) People rush wildly for open spaces, and remain all night out of doors.



In the third degree of the scale, I included at first the hasty dispersal of meetings; but, when the places at which this occurred are plotted on a map, it is evident that this effect would find an appropriate place under the second heading. A crowd in one room is more liable to excitement and fear than are persons in separate houses.

In the accompanying map, the dotted curves are the isoseismal lines as drawn by Captain Dutton. The continuous curves bound the areas in which the effects corresponding to the three higher degrees of the scale were observed. The curve for the first degree of course coincides with the outermost isoseismal line.

It will be seen that there is a certain rough agreement between these curves and the isoseismal lines. The curve D and the isoseismal 8 are not far apart; in other words, if the shock was strong enough to throw down chimneys or make cracks in the walls of buildings, then people thought it wiser to camp out for the night. The curve C and the isoseismal 6 coincide approximately; that is, people rushed precipitately into the streets if the movement made chandeliers, pictures, &c., swing. On the whole, the curve B roughly follows the isoseismal 3; so that, if the shock was not even strong enough to cause doors and windows to rattle, some persons were so alarmed that they left their houses, and public meetings were dispersed. Whether these effects were due to the rarity of the phenomenon or to the highly-strung nerves of the American people, it may, I think, be inferred that in no other civilised country would such alarm be shown at a sudden and unexpected occurrence.

Captain Dutton also gives many records of a feeling of nausea at the time of the earthquake; and, however excitable the observers may have been, these accounts are probably trustworthy, for this is not at all generally known to be a result of earthquake-motion. I have marked these places on a map, and it is curious that, with one or two exceptions, they all lie between the two broken lines of the figure. The most distant places at which the feeling was noticed are Blue Mountain Creek (New York), 823 miles, and Dubuque (Iowa), 886 miles, from Charleston. The outer boundary of the nausea area follows roughly the curve B, but is generally inside it; the inner boundary is so close to the curve C as to suggest that there may be some connection between them, that, in the wild hurry to reach the street, the slight feeling of nausea might escape notice.

CHARLES DAVISON.

THE CAMBRIDGE SENTINEL MILK STERILISER.

THIS is a simple and automatic milk steriliser for domestic use. It is made in three forms; in one, which is intended for use on an ordinary fire, a tube which carries an alarm bell at the top is inserted through the lid of the saucepan. When the desired temperature (85° C.) is reached, a trigger contained in the tube is automatically released, and the bell rings, thus warning the attendant to take the pan off the fire. In a second form the action is automatic. A saucepan containing the sensitive trigger is placed on a gas stove, and when the proper temperature is reached the release of the trigger causes the supply of gas to be automatically cut off. A third form is arranged for use with a spirit lamp. In each case, the automatic mechanism is actuated through the melting of an easily fusible alloy.

For the apparatus it is claimed (1) that it is simple and works automatically, (2) that the temperature (85° C.) attained does not impair the flavour or the nutritive qualities of the milk, (3) that injurious micro-organisms, including tubercle, are destroyed. Dealing with these claims in order, the apparatus certainly acts automatically and seems to be of simple construction. With regard to the first or bell form, however, the sound of the bell is so slightly audible that it would certainly be missed unless the attendant were listening for it, and in all probability in nine cases out of ten the milk would be boiled. The second form, with gas stove and automatic cut-off, works quite well and is much to be preferred. With regard to the temperature at which the signal is given or the cut-off takes place there is some difference, according to the amount of fluid which is being treated. Dealing with the two-pint size we have observed the following temperatures:

		Bell Form.	Cut-off Form.
Water	Half pint	94° and 95° C.	95° and 93° C.
	One pint	87·5° ,, 89°	86° ,, 87°
	Two pints	87° ,, 86°	84° ,, 85°
Milk	Half pint	98° (frothing)	95°
	Two pints	87°	84°

It will thus be seen that there is a considerable variation in the temperatures.

As to the second point, we consider that the temperature of 85° C. is too high, and we believe that the experiments of Duclaux and others have conclusively shown that milk cannot be heated above 70° C. without altering its flavour and nutritive qualities. Tested practically, milk heated in the apparatus and immediately cooled has a pronounced flavour, little less marked than milk which has been just boiled and then cooled. Three samples—(1) untreated, (2) sterilised in the apparatus and immediately cooled, (3) boiled and cooled—were submitted to three individuals, who separately tasted them; two of the individuals were unable to distinguish between the sterilised and boiled samples; the third said "that the sterilised sample seemed a little less boiled than the other." The flavour being so markedly altered, we doubt whether the claim that the nutritive qualities of the milk are unchanged can be substantiated.

The temperature 85° C. was probably chosen because it may be relied upon with certainty to kill pathogenic organisms, especially the tubercle bacillus. We believe, however, that a temperature of 65° C., acting for twenty minutes, is sufficient to kill the tubercle bacillus, and that, therefore, pasteurised milk, *i.e.*, milk heated to 68° C. for twenty minutes, is quite safe, and certainly its flavour is almost unaltered. We are aware, of course, that some observers claim that tuberculous milk may retain its infective properties after pasteurisation, but the work of Theobald Smith seems to explain the contradictory results which have been obtained. He found that tubercle bacilli suspended in water, saline solution, bouillon or milk were destroyed at 60° C. in 15—20 minntes. If, however, a pellicle forms on the milk, then the tubercle bacilli in the pellicle seem to be protected, and may survive an hour's heating at 60° C. (*Journ. Exper. Med.*, iv, 2, p. 217).

NEW SYNTHESES OF SOME DIUREIDES.

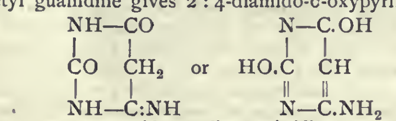
W. TRAUBE publishes in the present number of the *Berichte* further details on the new syntheses of uric acid, xanthine and the methyl derivatives of the latter—theobromine, theophylline and caffeine. The starting point is either cyanacetic acid or its ester. Cyanacetic acid and urea in presence of phosphorus oxychloride form cyanacetyl urea,

$$NH_2.CO.NH.CO.CH_2CN.$$

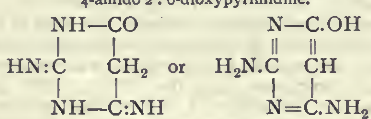
Also cyanacetic ester and guanidine combine with the separation of alcohol, forming cyanacetyl guanidine,

$$NH_2C(:NH).NH.CO.CH_2.CN.$$

The further treatment of these two compounds is similar. With alkalis they are converted into cyclic (pyrimidine) compounds. Cyanacetyl urea forms 4-amido-2 : 6-dioxypyrimidine, whilst cyanacetyl guanidine gives 2 : 4-diamido-6-oxypyrimidine

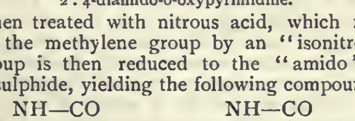


4-amido 2 : 6-dioxypyrimidine.

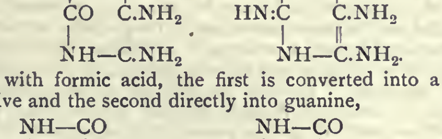


2 : 4-diamido-6-oxypyrimidine.

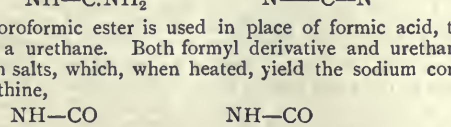
They are then treated with nitrous acid, which replaces the hydrogen of the methylene group by an "isonitroso" group, and this group is then reduced to the "amido" group by ammonium sulphide, yielding the following compounds:



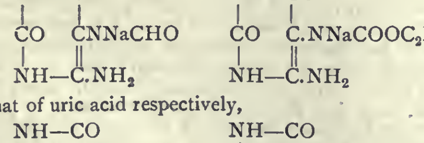
Boiled with formic acid, the first is converted into a formyl derivative and the second directly into guanine,



If chloroformic ester is used in place of formic acid, the first yields a urethane. Both formyl derivative and urethane form sodium salts, which, when heated, yield the sodium compound of xanthine,



and that of uric acid respectively,



Sodium xanthine. Sodium urate.

Guanine may be readily converted by Fischer and Strecker's method into xanthine, and by methylation into theobromine and caffeine, whereas by using methyl urea in the formation of cyanacetyl urea in the first method, or by methylating the formyl compound, theobromine, theophylline, caffeine and the corresponding uric acids may be produced. A patent has been taken out by the discoverer for these processes.

ARTIFICIAL RAIN.[1]

THE question perpetually arises in the popular mind as to whether man cannot produce rain or drought according as his needs may dictate. The possibility of doing this is never questioned by barbarians, who have their professional rain makers and great medicine men, and superstitiously attribute to them all power over nature. In some parts of the Christian world it has been believed that man could bring about rain or drought, not by his own power, but by intercession with the Creator, who would, perhaps, work a miracle on his behalf. During the past thousand years miracles have been confessedly rare, and some consider it almost impious for a man to dare to interfere with the operations of nature on a large scale; some even refuse to be doctored for disease.

The recognition of the truths revealed by modern science has made it evident that man can affect the weather only by understanding and making use of the laws of nature. He must do it in a natural or scientific way, not through any supernatural power or in any miraculous way. In fact, those who have a very imperfect knowledge of the laws of nature, if any at all, are often inclined to believe that there really must be some process known to science, or still to be discovered, by which man can bring abundant rain from the clouds when and where he needs it. They point to the popular belief that rain follows great battles, as proving that there is some way by which to affect the clouds—it may be through the noise of the battle, or it may be the burning of the gunpowder, or it may be a possible electric disturbance. They point to the reputed influence of lightning rods, which are supposed to draw the lightning from the skies and prevent the formation of hail.

In these and other matters there is abundant room for self-deception. It would be a great mistake to conclude that any battle by reason of its noise, or heat, or gunpowder has had any effect in the way of producing rain, or that the lightning rods have had any effect in producing or preventing hail. The statistics that are supposed to substantiate such conclusions do not really prove anything of the kind, and yet many are deceived by them because in reasoning upon the phenomena of nature they forget to apply the simplest laws of logic, and are carried away by emotions or preconceived opinions or the plausible suggestions of others. This is not at all singular, for the history of man's progress in knowledge is the history of a long series of mistakes covering thousands and tens of thousands of years. All have to learn by bitter experience, and if science seems to have made rapid progress during the past century, that should not blind our eyes to the fact that errors may still prevail among the professional men of science as well as the rest of mankind.

In the special matter of the artificial formation of rain we heartily endorse the statement that if it is in any way possible to bring this about we must labour to discover it; in fact, we eventually shall discover the way, if there be one, but thus far nothing has been accomplished to justify us in believing that feasible methods exist or are likely to exist. Various methods have had their advocates both in Europe and America, and the citizens of the United States, with a nervous energy that is greatly to be admired, have given a full and fair trial, at great expense, to several methods advocated by men of imperious natures that would brook no denial short of nature's own experimental demonstration of their errors. Thus the rain-making by explosives was most thoroughly tested by order of Congress at an expense to the public of many thousands of dollars, and the results have been discussed sufficiently, both in public and private, to show that nothing in the way of rain, and probably nothing in the way of cloud or mist, was produced. One of the first experimental trials was made quite near Washington, D. C., at night-time, November 2–3, 1892, when a series of clouds with showers were passing over the neighbouring country, and these continued right along for several hours

[1] Abridged from a contribution by Prof. Cleveland Abbe to the U.S. *Monthly Weather Review*.

quite independent of the bombardment. The reports from numerous observers showed that as the showers moved along over the earth's surface those in front of it reported that the noise of the exploding dynamite occurred just before the shower; those in the wake of the shower reported that the shower came before the explosion, while those in the midst of the shower, of course, heard the explosion while it was raining. There was no evidence that the explosion had any effect on the clouds. Careful observations in Washington, D.C., during the whole of this first experiment, and during subsequent experiments with explosives, warranted the conclusion that no rainfall was produced by bombardment.

About that time a "rain wizard" commenced operating in Ohio. His method consisted in locking himself in a barn, house, luggage van or other room, wherein he made a fire and burned or evaporated certain chemicals, the smoke of which rose through the roof out of some impromptu chimney or stove-pipe and dissipated itself in the thin air. Of course it was claimed that the chemicals exerted a great influence on the atmosphere and forced rain to come. Occasionally rain did come after one, two, or three days of a chemical performance, but equally often it did not come. The Weather Bureau was often importuned for advice as to when the wizard should be called to any given town, and whether the inhabitants would be justified in paying him his fee of several hundred dollars. Eventually, a prominent railway company rigged up a car for his use, and during the years 1892–4 made it convenient for all the citizens on its lines to invoke the aid of "the rain producer." Of course there were numerous cases in which the operations were followed by rain; those who studied the Daily Weather Map could see at a glance that these rains accorded with the general weather conditions and had nothing to do with the rain-making operations. So long as frequent rains occurred, although they were natural and were predicted by the Weather Bureau on the basis of the weather map from day to day, yet the farmers of Iowa, Kansas and Nebraska, ignoring this fact, were sure to accredit all success to the wizard.

During the last great drought in California, 1898–1899, the citizens of one city authorised an extensive and expensive system of experiments by gases and by cannon, but were fortunately saved the necessity of actually wasting their money by the fact that an abundant rain fell naturally just before they were ready to begin their own operations.

Occasionally we still receive newspaper items reviving the old story that floods of rain were broken up by cannonading at Rome, or that rain was produced by cannonading in Italy, or that hailstorms were averted from a special vineyard that was protected by lightning rods while neighbouring vineyards suffered. These are all repetitions of the same old myths, or repetitions of useless experiments, and the intelligent reader may dismiss them as having no foundation. No matter how severely his land may be suffering from drought or flood, he should seek some other mode of relief and not waste his time and money in efforts to change the nature of the clouds or the atmosphere.

ON THE STATISTICAL DYNAMICS OF GAS THEORY AS ILLUSTRATED BY METEOR SWARMS AND OPTICAL RAYS.[1]

IMAGINE a cloud of meteors pursuing an orbit in space under outside attraction—in fact, in any conservative field of force. Let us consider a group of the meteors around a given central one. As they keep together their velocities are nearly the same. When the central meteor has passed into another part of the orbit, the surrounding region containing these same meteors will have altered in shape; it will in fact usually have become much elongated. If we merely count large and small meteors alike, we can define the density of their distribution in space in the neighbourhood of this group; it will be inversely as the volume occupied by them. Now consider their deviations from a mean velocity, say that of the central meteor of the group; we can draw from an origin a vector representing the velocity of each meteor, and the ends of these vectors will mark out a region in the velocity diagram whose shape and volume will represent the character and range of deviation. It results from a very general proposition in dynamics that as the central meteor moves along its path the region occupied by the group of its neighbours multiplied by the corresponding region in their velocity diagram remains constant. Or we may say that the density at the group considered, estimated by mere numbers, not by size, varies during its motion proportionally to the extent of the region on the velocity diagram which corresponds to it.

This is true whether mutual attractions of the meteors are sensibly effective or not; in fact, the generalised form of this proposition, together with a set of similar ones relating to the various partial groups of coordinates and velocity components, forms an equivalent of the fundamental principle of Action which is the unique basis of dynamical theory.

Now, suppose that the mutual attractions are insensible, and that W is the potential of the conservative field: then for a single meteor of mass m and velocity v we have the energy $\frac{1}{2}mv^2+m\mathrm{W}$ conserved: hence if δv_1 be the range of velocity at any point in the initial position, and δv_2 that at the corresponding point in any subsequent position of the group, we have $v_1\delta v_1=v_2\delta v_2$, these positions remaining unvaried and the variation being due to different meteors passing through them. But if $\delta\omega_1$ and $\delta\omega_2$ are the initial and final conical angles of divergence of the velocity vectors, corresponding regions in the velocity diagram are of extents $\delta v_1 . v_1^2\delta\omega_1$ and $\delta v_2 . v_2^2\delta\omega_2$: these quantities are, therefore, in all cases proportional to the densities at the group in its two positions. In our present case of mutual attractions insensible, the volume density is thus proportional to $v\delta\omega$, because $v\delta v$ remains constant. Now the number of meteors that cross per unit time per unit area of a plane at right angles to the path of the central meteor is equal to this density multiplied by v: thus here it remains proportional to $v^2\delta\omega$, as the central meteor moves on. In the corpuscular formulation of geometrical optics this result carries the general law that the concentration in cross-section of a beam of light at different points of its path is proportional to the solid angular divergence of the rays multiplied by the square of the refractive index, which is also directly necessitated by thermodynamic principles; as a special case it limits the possible brightness of images in the well-known way.

In the moving stream of particles we have thus a quantity that is conserved in each group—namely, the ratio of the density at a group to the extent of the region or domain on the velocity diagram which corresponds to it; but this ratio may vary in any way from group to group along the stream, while there is no restriction on the velocities of the various groups. If two streams cross or interpenetrate each other, or interfere in other ways, all this will be upset owing to the collisions. Can we assign a statistical law of distribution of velocities that will remain permanent when streams, which can be thus arranged into nearly homogeneous groups, are crossing each other in all directions, so that we pass to a model of a gas? Maxwell showed that if the number of particles each of which has a total energy E is proportional to $\epsilon^{-h\mathrm{E}}$, where h is some constant (which defines the temperature), while the particles in each group range uniformly, except as regards this factor, with respect to distribution in position and velocity jointly, as above, then this will be the case. In fact, the chance of an encounter for particles of energies E and E′ will involve the product $\epsilon^{-h\mathrm{E}}\epsilon^{-h\mathrm{E}'}$ or $\epsilon^{-h(\mathrm{E}+\mathrm{E}')}$, and an encounter does not alter this total energy E + E′; while the domains or extents of range of two colliding groups each nearly homogeneous and estimated, as above, by deviation from a central particle in position and velocity jointly, will have the same product after the encounter as before by virtue of the Action principle. It follows that the statistical chances of encounter, which depend on this joint product, will be the same in the actual motion as are those of reversed encounter in the same motion statistically reversed. But if the motion of a swarm with velocities fortuitously directed can be thus statistically reversed, recovering its previous statistics, its molecular statistics must have become steady; in fact, we have in such a system just the same distribution of encountering groups in one direction as in the reverse direction: thus we have here one steady state. The same argument, indeed, shows that a distribution, such that the number per unit volume, of particles whose velocity deviations correspond to a given region in the velocity diagram, is proportional to the extent of that region without this factor $\epsilon^{-h\mathrm{E}}$, will also be a steady one. This is the case of equable distribution in each group as regards only the position and velocity diagrams conjointly; but in this case each value of the resultant velocity would occur with a frequency

[1] A paper read by Dr. J. Larmor, F.R.S., before Section A of the British Association at Bradford, September, 1900.

proportional to its square, and a factor such as e^{-hE} is required to keep down very high values. The generalisations by Boltzmann and Maxwell to internal degrees of freedom would lead us too far, the aim here proposed being merely concrete illustration of the very general but purely analytical argument that is fully set forth in the treatises of Watson, Burbury and Boltzmann.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. H. Herbert Smith has been appointed Gilbey lecturer in agriculture for the next three years. Prof. Macalister and Dr. Habershon have been appointed additional examiners for medical degrees.

The Walsingham Gold Medal in biology has been awarded to Mr. H. Dale of Trinity College, and the Bronze Medal to Mr. R. C. Punnett of Caius College.

The University of New Brunswick has been affiliated to the University of Cambridge.

The researches submitted to the Board for physics by Mr. J. B. B. Burke, Mr. W. C. Henderson and Mr. A. H. Peake, advanced students, have been approved as qualifying for the B.A. degree.

Dr. Anningson, Dr. Collingridge, Prof. Sims Woodhead and Dr. Tatham have been appointed examiners in sanitary science.

The proposal for enabling the examiners to award a first class to candidates for the Natural Sciences Tripos, Part II., who show a sufficient knowledge of two subjects, but do not quite attain the first class standard in either, has been rejected by the Senate.

THE Childhood Society offers prizes of two guineas and one guinea for the two best essays on some prescribed subjects referring to the mental and physical characteristics of children. Information can be obtained from the Hon. Secretary of the Society, 72 St. Margaret Street, London, W.

GLANCING through the Calendar of the University College at Nottingham, we notice the announcement that the Board of Education is prepared to pay three-fourths of the laboratory fees at the College of Government teachers engaged in science teaching who wish to become familiar with practical methods. This rule applies to other University Colleges.

SCIENTIFIC SERIALS.

American Journal of Science, November.—Elaboration of the fossil cycads in the Yale Museum, by L. F. Ward. The collection contains twenty-nine different species of cycads from the Black Hills, represented by nearly eight hundred specimens. A number of new species are described, and termed respectively Cycadeoidea superba, rhombica, heliochorea, utopiensis, reticulata, minima, and protea.—Chemical composition of turquoise, by S. L. Penfield. Turquoise is so uniform in its chemical constitution that it can hardly be considered an accidental mixture of an aluminium phosphate and a copper phosphate. Copper and iron must be regarded as constituents rather than impurities. The author derives it from ortho-phosphoric acid, in accordance with the formula

$$[Al(OH)_2, Fe(OH)_2, Cu(OH), H]_3PO_4.$$

—Quartz-muscovite rock from Belmont, Nevada, by J. E. Spurr. The rock described occurs in a large dyke just east of Belmont. It occurs in large masses, changing gradually and irregularly into alaskite or muscovite-biotite granite. It is identical with the "beresite" occurring in the Urals in association with veins of auriferous quartz.—Volumetric estimation of copper as the oxalate, with separation from cadmium, arsenic, tin and zinc, by C. A. Peters. The precipitation of copper oxalate from solutions containing at least 0·0128 grammes of the oxide and saturated with oxalic acid is practically complete. Moderate amounts of copper may be determined quantitatively as the oxalate by precipitation with oxalic acid and titration of the precipitate by potassium permanganate. Copper may also be separated from other metals in the presence of nitric acid by the addition of considerable amounts of oxalic acid.—Synopsis of the collections of invertebrate fossils made by the Princeton expedition to Southern Patagonia, by A. E. Ortmann. Thirty-six new species are described, mostly gastropoda.—The kathode stream and X-light, by W. Rollins. The author advances two arguments against the supposition that the kathode stream particles are always of the same size, move with the same speed, and carry the same charge. Mercury particles appear too heavy to generate X-rays, and the loss of material from kathodes of different metals is not the same.

Bollettino della Società Sismologica Italiana, vol. vi., 1900–1901, No. 4.—The great earthquake of June 12, 1897, by R. D. Oldham. A summary of the author's report on the great Indian earthquake, and of his memoir on the propagation of earthquake motion to great distances (*Phil. Trans.*, 1900A, pp. 135–174).—A new protographic seismic pendulum, by G. Costanzi. A description of an apparatus for recording only the first part of the earthquake-motion, the surface on which the record is made being withdrawn from the moving pendulum.—Principal eruptive phenomena in Sicily and the adjacent islands during the year 1899, by S. Arcidiacono.—Notices of earthquakes recorded in Italy (June 5 to August 4, 1899), by A. Cancani, the most important being the Tuscan earthquake of June 27, the Latian earthquake of July 19, and distant earthquakes on June 5, 14, 17, July 7, 11, 12 and 14.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, November 15.—Mr. C. B. Clarke, Vice-President, in the chair.—Mr. W. B. Hemsley, F.R.S., F.L.S., exhibited a number of specimens and drawings of Fitchia (Hook. f. in *Lond. Journ. Bot.* iv. p. 640, pls. 23, 24), including a new species from the island of Raratonga in the Cook Archipelago, discovered by Mr. T. F. Cheeseman. The genus was described from specimens thought to have been procured on Elizabeth Island, a remote coral island in the Eastern Pacific; but Mr. Hemsley gave reasons for believing that the locality of the plant described by Sir Joseph Hooker was Tubnai Island in the same latitude, but 20° further to the west: an island of volcanic origin and mountainous, and, therefore, more likely than a coral island to be the habitat of such a plant, especially as it was originally discovered by Banks and Solander in Tahiti. Only three or four species are known: they are small resiniferous shrubs of tree-like habit, with rather thick branches, opposite simple leaves borne on slender stalks, and terminal, usually solitary flower-heads. Mr. Hemsley next exhibited an abnormal cluster of fruits of the edible chestnut found by Mr. Charles Read of Sway in the New Forest, and forwarded to Kew by the Rev. J. E. Kelsall. Usually there are two or three, rarely four in a cluster; but in the specimen exhibited there were at least fifteen, the largest nuts measuring about an inch in their greatest diameter. He also exhibited a curious flask-shaped bird's nest, which had been sent to Kew by Mr. J. H. Hart, Director of the Botanic Garden, Trinidad, but without any information concerning the bird which built it. It was constructed almost entirely of the soft plumose seeds of a species of Tillandsia (Bromeliaceæ). It measured a foot in length and between four and five inches in its greatest diameter, and had the entrance at the base, the receptacle for the eggs being near the top of the inside. Mr. J. E. Harting, in reply to a question from the chairman, said that without seeing a specimen of the bird which had built the nest in question, it was not easy to name the species with certainty; but that it was doubtless the nest of an Icterus, and probably of *Icterus leucopteryx*, commonly known in the West Indies as the Banana-bird.—Mr. James Groves, on behalf of Mr. Cecil R. P. Andrews, exhibited specimens of a Sea Lavender new to the Channel Islands, *Statice lychnidifolia*, Girard, discovered by Mr. Andrews in August of the present year growing sparingly on low rocks by the sea in Alderney in company with *S. occidentalis*, the most nearly allied British species. Mr. Groves pointed out that the interest of the record consisted, not so much in the fact of the plant occurring in Alderney (being a native of the adjacent French coast, and the Channel Islands being geographically more French than British), as in the fact that a species should be added to the flora of one of our possessions so near home.—Mr. W. C. Worsdell read a paper entitled "Further Observations on the Cycadaceæ," intended to throw additional light on the problem as to the phylogenetic origin and relationships of this group of plants.—On behalf of Miss Alice L. Embleton a paper was read by Prof. G. B. Howes on

a new entozoic Copepod (*Goidelia echiura*) found together with an Infusorian (*Trichodina*) in the rectum of a new Japanese marine Worm (*Echiurus unicinctus*) recently described by her in the Society's *Transactions*. This Copepod is eyeless, and a description was given of its appendages in both the adult and metamorphic stages, from careful dissections under the microscope made in one of the laboratories of the Royal College of Science.

Geological Society, November 21.—J. J. H. Teall, F.R.S., President, in the chair.—A Monchiquite from Mount Girnar, Junagarh (Kathiawar), by Dr. J. W. Evans. After a brief account of the rocks of the monchiquite-type, in which ferromagnesian silicates are embedded in an isotropic matrix with the chemical constitution of analcime, the author describes an example from Mount Girnar, where it is associated with a nepheline-syenite intrusive in a mica-augite-diorite. The most striking feature of this rock is the occurrence of colourless spheres of various sizes up to about 1 mm. in diameter. The rest of the rock is mainly composed of a hornblende of the barkevikite-type; a pale green augite is also present.—The geology of Mynydd-y-Garn (Anglesey), by Charles A. Matley. Mynydd-y-Garn, a hill of less than 600 feet elevation, stands above the village of Llanfair-y'nghornwy in north-west Anglesey. The mass of the hill is an inlier of sericitic and chloritic phyllites (Garn Phyllites), surmounted by a massive conglomerate (Garn Conglomerate), and surrounded by black slates and shales of apparently Upper Llandeilo age. The general dip of all the rocks is northerly and north-easterly. The Garn Phyllites are usually green altered shales and fine gritty rocks, and are intensely contorted near their southern boundary. Even where not contorted they show under the microscope evidence of powerful earth-movement. They are considered by the author to be part of the "Green Series" of northern Anglesey. They are cut off to the west and south by a curved fault, probably a thrust, which brings them against Llandeilo slates and breccias. The district around Mynydd-y-Garn has been affected since Llandeilo times by two powerful earth-movements, acting one from the north, the other from the north-east. The first-mentioned prevailed in the area west and north-west of the hill, where the pre-Llandeilo rocks are frequently shattered to crush-conglomerates. Around Mynydd-y-Garn itself and east of it the principal direction of movement has been from the north-east; south of the hill the structure is, perhaps, the result of the interference of these two movements.—On some altered tufaceous rhyolitic rocks from Dufton Pike (Westmorland), by Frank Rutley, with analyses by Philip Holland. The specimens described were collected by the late Prof. Green and Mr. G. J. Goodchild from the Borrowdale volcanic series which constitutes the central mass of Dufton Pike, and the chief interest attaching to them is their alteration, probably as the result of solfataric action.

Anthropological Institute, November 22.—Mr. W. Gowland, Vice-President, in the chair.—A paper was read by Messrs. MacIver and Wilkin on their Algerian journey. The main object of the journey was to investigate the evidence for the Libyan origin of Prof. Flinders Petrie's "New Race." The districts especially investigated were the Aurès mountains, inhabited by the Chawia, and Kabylia; and a large number of lantern slides were secured which were exhibited in illustration of the paper. The manufacture of pottery was described in detail; the readers considered that the identity of one entire class of Kabyle ware with that of prehistoric Egypt in respect of colour, technique, and details of ornament, as well as numerous coincidences of form, proved the close culture connection of the ancestors of the Berbers with prehistoric Egypt. Other classes of pottery seemed to have been directly derived from or communicated to Cyprus. Turning to questions of anthropography, the readers showed that the Berbers are essentially a white race with brown-black hair, brown or hazel eyes and a skin which is really red-white. They are, therefore, the true representatives of the white Libyans of the Egyptian wall-paintings. Blondes occur but seldom; they form not more than 10 per cent. The paper concluded with a summary of the results of an anthropometrical examination of a very large series of prehistoric Egyptian and modern Berber skulls; the results showed the two races to be quite distinct. The expedition has strengthened the case for culture connection between Libya and Egypt, but disproved the theory of common race.

November 27.—Mr. C. A. Read, President, in the chair.—Prof. E. B. Tylor communicated, and commented on, a paper by Mr. Paxton Moir on stone implements in Tasmania. The paper described the sites on which the stones were found and the uses to which the various forms were put. The types included knives and hand axes which were fairly common, and also a certain number of concave "scrapers" and pointed "groovers." There was, however, considerable difference of opinion as to the propriety of using a very definite terminology and attributing to the manufacturers very definite intentions where there was obviously very little command over the materials. Another point which roused some discussion was whether the stones were shaped to fit the hand or selected because they were so shaped, or whether the adaptability of the hand did not account for the readiness with which a "grip" was found.—A large number of Tasmanian implements being on the table, the points raised in the discussion received practical illustrations. There were also exhibited, on behalf of Mr. Alfred Sharpe, C.B., H.B.M. Commissioner of Nyassaland, a double clapperless bell, a stone implement of uncertain use, and a wooden stool supported on a carved female figure with prominent keloid scars, and native head-dress, from Angoniland.

Royal Microscopical Society, November 21.—Mr. Wm. Carruthers, F.R.S., President, in the chair.—Mr. Nelson exhibited and described an erect image dissecting microscope by Leitz, and sent for exhibition by Mr. C. Baker. The erection of the microscopic image, effected by means of Porro prisms, was first described by Ahrens in the *Journal* of the Society in 1888. The instrument was valuable as a dissecting microscope; it was provided with handrests and three objectives, having a very long working distance.—Mr. Disney exhibited a diffraction plate having the lines ruled in concentric circles, by which the diffraction bands were separated with great clearness. The rulings were about 7000 to the inch. He also exhibited a steel brooch the surface of which had been ruled in the same way.—Mr. C. F. Rousselet exhibited an electric lamp for use with the microscope.—The president called attention to the exhibition that evening of a number of slides from the Society's cabinet, prepared by the late Dr. Carpenter in connection with his investigations into the shells of the mollusca. Mr. B. B. Woodward also exhibited some preparations.—Prof. Chas. Stewart referred to the views held upon shell structure at the present day, and, taking the common pinna shell as an example, demonstrated how its structure was built up. Besides studying the sections usually made, he recommended that shells should be broken and the fractured surfaces examined, if a correct idea of the formation of the shells was to be obtained.

Zoological Society, December 4.—Dr. Henry Woodward, F.R.S., Vice-President, in the chair.—The Secretary read an extract from a letter which had been addressed to the Colonial Office by the West India Committee, concerning the proposed introduction of the English starling or the Indian mynah into St. Kitts, West Indies, to check the increase of grasshoppers, which were causing great damage to the growing crops in that island.—Mr. R. Lydekker exhibited, on behalf of Mr. Rowland Ward, and made remarks upon the mounted skin of a female musk-ox which had been obtained from East Greenland.—Dr. C. I. Forsyth Major exhibited and made remarks on some remains of *Cyon* from Sardinia, and of a monkey (*Macacus*, sp. inc.) from Mauritius.—Mr. A. H. Cocks made some remarks on the period of gestation of the pine-marten (*Mustela martes*), which he had ascertained could not be less than ninety-four days and might possibly be as much as 106 days.—Mr. J. S. Budgett read a paper on the breeding-habits of *Protopterus*, *Gymnarchus*, and some other West African fishes, in which an account was given of a collecting trip made during last summer to the swamps of the Gambia River in search of the eggs of *Polypterus*. The eggs of *Polypterus* were not discovered, though a very young specimen, measuring only one inch and a quarter in length, was found. In this small specimen the dermal bones were not developed, and the external gills were of very great size, the base of the shaft being situated immediately behind the spiracle. The dorsal finlets formed a continuous dorsal fin. While Mr. Budgett was in search of the eggs of *Polypterus*, the underground nests of *Protopterus annectens* were found in abundance, and complete series of eggs and larvæ were preserved. The male *Protopterus* was found to live in the nest until the larvæ were fit to leave it. Nests were also found of the curious fish *Gymnarchus niloticus*. These were made in

about three feet of water, and floated on the surface. The nest was two feet long and a foot wide; the walls of the nest stood several inches out of the water around two sides and one end. The opposite wall was low, and here was the entrance to the nest. Nests of *Heterotis niloticus*, *Hyperopisus bebe* and *Sarcodaces odoë* were also described.—A series of papers on the collections made during the "Skeat Expedition" to the Malay Peninsula in 1899–1900 was read. Mr. J. Lewis Bonhote reported on the mammals, and enumerated the fifty-four species of which specimens had been obtained. One new species was described as *Mus ciliata*. Mr. N. Annandale gave a short description, illustrated with lantern slides, of the country traversed, and read the notes he had made on the habits and natural surroundings of the insects he had observed. Mr. F. F. Laidlaw gave an account of the frogs collected by himself and Mr. Annandale; they embraced examples of twenty-nine species, of which four, viz. *Rana signata*, *R. Lateralis*, *Bufo jerboa* and *Microhyla inornata*, had not previously been recorded from the Malay Peninsula. The earthworms collected during the expedition were reported upon by Mr. F. E. Beddard, who described from amongst them ten new species belonging to the genus Amyntas.—A communication was read from Dr. Arthur G. Butler containing an account of the butterflies collected by Mr. Richard Crawshay in the Kikuyu Country of British East Africa in the years 1899 and 1900. The species represented in the collection were 116 in number, six of which were described as new in the paper.—Mr. R. Newstead contributed a paper on a new scale-insect (*Walkeriana pertinax*), collected by H.B.M. Commissioner Alfred Sharpe, C.B., at Zomba, British Central Africa, which was stated to be probably the largest species of Coccid yet discovered, the maximum measurements being 20·50 mm. long and 10 mm. high. As in the genus *Callipappus* the abdomen was intus-suscepted, forming a pouch for the reception of the ova and the hatching of the larvæ. 6258 of the latter were taken from the body of a single female.

EDINBURGH.

Royal Society, November 19.—Prof. Copeland, Vice-President, in the chair.—The chairman gave the substance of communications from the Scottish Office, Whitehall, and from the Nobel Committee of the Royal Swedish Academy of Sciences, as to the Nobel Foundation.—In a paper on the diurnal range of temperature in the Mediterranean during the summer months, Dr. Buchan gave some important conclusions based on the observations made by the staff of the Austrian ship *Pola*. These had been taken at various depths, and a study of them showed that in water deeper than 100 fathoms a daily change of temperature could be detected to a depth of about 150 feet. Thus averaging from 50 distinct sets of observations, he found that the temperature of the surface waters in the afternoon was greater than the temperature in the morning by 1·5° F., and that this difference gradually diminished with increase of depth, having for example the value 0·3° F. at a depth of 100 feet. That such a depth should be reached by the solar radiation seemed very remarkable, and the process by which the heat was lost during the night seemed to demand a careful consideration of our theories of radiation.—Dr. Alexander Bruce read an elaborate paper on the topography of the gray matter and motor cell in the spinal cord, the results being demonstrated by a series of finely prepared lantern slides.

PARIS.

Academy of Sciences, December 3.—M. Maurice Lévy in the chair.—Study of the carbide of samarium, by M. Henri Moissan. A mixture of samarium oxide and carbon, submitted to the temperature of the electric furnace, gives easily a crystallised carbide of the formula SaC_2, comparable with the oxides of lanthanum, cerium, neodymium and praseodymium. This carbide decomposes cold water in a similar manner to the carbides of the alkaline earths, giving a complex mixture of hydrocarbons, rich in acetylene. In this respect samarium behaves more like the ytrrium group and differs from the cerium group of rare earths.—Observations of the comet, 1900 *b* (Borrelly-Brooks) made with the large equatorial of the observatory of Bordeaux, by MM. G. Rayet and A. Feraud. The positions of this comet were measured on nine evenings between September 13 and October 25. On the latter date the comet had still a very faint tail, and the nucleus was slightly elongated.—The changes of solar temperature and the variations of rain in regions surrounding the Indian Ocean, by Sir Norman Lockyer and Dr. W. J. S. Lockyer. A connection is traced between the occurrence of dry and wet seasons and the maximum and minimum temperatures of the sun, as determined by the area of sun spots.—New comparative researches on the products of combustion of different apparatus for lighting, by M. N. Gréhant. The products of combustion from incandescent burners, candles and petroleum lamps were compared, with especial reference to the amount of carbon monoxide produced. The results are best compared by examining the ratio of the volumes of $CO : CO_2$ produced. This ratio was 1 : 655 for the Auer burners, 1 : 1025 for the oil lamps and 1 to 1610 for the candles.—On isothermal surfaces, by M. A. Thybout.—On the minimum of certain integrals, by M. H. Lebesgue.—Geometrography in space, by M. Émile Lemoine.—On the theory of electrocapillary phenomena, by M. Gouy. The author states that the view generally held as to the causes of electrocapillary phenomena, the Helmholtz hypothesis of double layers, is not in accord with experiment. The view is here put forward that forces exist between the mercury and the ions or molecules of the dissolved body which are non-electrical. This leads to the conclusion that there exists in general a triple electric layer, which may, in certain cases, be reduced to a double layer.—Acidimetry of the aldehydes and ketones, by MM. A. Astruc and H. Murco. The behaviour of a large number of fatty and aromatic aldehydes and ketones towards helianthine A, phenolphthalein, and Porrier's blue has been studied. The results are in general accord with the thermochemical data.—On some reactions of substituted anilines, by M. Œchsner de Coninck. An account of the reactions between methyl-, dimethyl-, ethyl-, and diethyl-aniline and copper sulphate, chloride, and acetate, and nickel and cobalt chlorides.—On the presence of an iron thiocarbonate in the water of the Rhone, by M. H. Causse. At certain times of the year the Rhone water possesses the property of restoring the colour to Schiff's reagent. After proving that no aldehyde was present in the water, the reaction was proved to be caused by a thiocarbonate of iron, $FeCO_2S$, which was made synthetically in two or three ways. There appears to be some connection between the amount of this substance present in the Rhone water and the number of cases of typhoid fever in the Rhone valley.—Determination of over-heating or under-heating of plaster of Paris in furnaces, by M. L. Périn.—Permeability of the external wall of the marine invertebrate, not only to water but also to salts, by M. R. Quinton. It is shown experimentally in a decisive manner that the external wall of the marine invertebrate is permeable, not only to water, but to such salts as sodium chloride and phosphate. Hence the higher marine invertebrate, although closed anatomically, is osmotically open, and hence resembles the lower marine invertebrate, physiologically and anatomically, in being a colony of marine cells.—A volatile poison, the cutaneous secretion of *Iulus terrestris*, by M. C. Phisalix. During a research on the action of this venom upon guinea-pigs, it was found that the poison was volatile; hence it is probable that the active principle is not an albumenoid material.—The large migratory Acridians of the Old and New World of the genus Schistocera; their changes in colour according to age and season; the physiological *rôle* of pigments; by M. J. Künckel d'Herculais.—On the disease of the carnation produced by *Fusarium Dianthi*, by M. G. Delacroix. The conidia of *Fusarium Dianthi* can be killed in seven hours by the vapour of carbon bisulphide. Ordinary formalin of commerce, diluted with one thousand parts of water, kills the chlamydospores in an hour.—On the simultaneous production of two nitrogen compounds in the crater of Vesuvius, by M. R. V. Matteucci. During the recent eruption, the simultaneous ejection of rocks covered with sal ammoniac and iron nitride was noticed, and these are regarded as being intimately related in their formation.—Remarks by M. Armand Gautier on the preceding paper.—On the tectonic continuity of Tonkin with China, by M. A. Leclère.—Chemical and mineralogical examination of the Lançon meteorite, by M. Stanislas Meunier.—On some therapeutic applications of light, by M. P. Garnault. Light may be utilised with great advantage in a certain number of diseases, and the results obtained are certainly due to its specific action. The cases most successfully treated are muscular and chronic articular rheumatism, various ulcers and chronic catarrh of the nose and ear.

NEW SOUTH WALES.

Royal Society, October 3.—The President, Prof. Liversidge, F.R.S., in the chair.—Marriage and descent among the Australian aborigines, by R. H. Mathews.—On the constituent of peppermint odour occurring in many Eucalyptus oils, part i., by Henry G. Smith. The first Eucalyptus oil was distilled by Dr. White in 1788, at Sydney, and owing to the great resemblance between this oil and that obtained from the peppermint *Mentha piperita*, he named the tree from which he had obtained the oil the "Peppermint Tree." Its botanical name is *Eucalyptus piperita*. Since then many other species of Eucalyptus have been found to have this peppermint odour, and are generally known as "peppermints." The constituent giving this odour has now been isolated. It occurs in greatest amount in the oil obtained from the leaves of *E. dives*, next in that of *E. radiata*, and in fair amount in the oils of several other species.—On the crystalline structure of gold nuggets from Klondyke, Victoria and New Zealand, by Prof. Liversidge, F.R.S. Sections of three nuggets from Klondyke were shown. The crystal faces are comparatively small, and the nuggets have a granular structure, as if built up of separate grains, of one or two millimetres in diameter. They are also more fissured and contain more cavities than usual. The sections of Victorian (Australian) and New Zealand nuggets are also made up of small crystals, and they present numerous small cavities after the removal of the quartz and iron oxide by treatment with hydrofluoric and hydrochloric acids, so that the sections present quite a different appearance to the very compact and largely crystallised nuggets from West Australia.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 13.

ROYAL SOCIETY, at 4.30.—On the Spectrum of the More Volatile Gases of Atmospheric Air, which are not Condensed at the Temperature of Liquid Hydrogen. Preliminary Notice: Prof. Liveing, F.R.S., and Prof. Dewar, F.R.S.—Additional Notes on Boulders and other Rock Specimens from the Newlands Diamond Mines, Griqualand West: Prof. Bonney, F.R.S.—The Distribution of Vertebrate Animals in India, Ceylon and Burma: Dr. W. T. Blanford, F.R.S.—Elastic Solids at Rest or in Motion in a Liquid: Dr. Chree, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—The Syzygetic Theory of Orthogonal Bivariants: Prof. Elliott, F.R.S.—On Discriminants and Envelopes of Surfaces: R. W. Hudson.—Note on the Inflexions of Curves with Double Points: H. W. Richmond.—On some Properties of Groups of Odd Order, ii.: Prof. Burnside, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Possible continuation of Discussion on Mr. Langdon's paper.——*Time permitting*: Rapid Variations in the Current through the Direct Current Arc: W. Duddell.

CHEMICAL SOCIETY, at 8.30.—Rammelsberg Memorial Lecture: Prof. H. A. Miers, F.R.S.

FRIDAY, DECEMBER 14.

PHYSICAL SOCIETY (Royal College of Science), at 5.—(1) Electric Inertia; (2) The Effect of Inertia on Electric Currents in a Rotating sphere: Prof. A. Schuster, F.R.S.—Exhibition and Description of a Quartz-Thread Gravity-Balance: Prof. R. Threlfall, F.R.S.—On the Theory of Magnetic Disturbances by Earth Currents: Prof. A. W. Rücker, F.R.S. Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents: Dr. R. T. Glazebrook, F.R.S.—The New Physical Laboratories of the Royal College of Science: Prof. A. W. Rücker, F.R.S.—Exhibition of a Set of Half-Seconds Pendulums: W. Watson.

ROYAL ASTRONOMICAL SOCIETY, at 8.—On the Connection between Solar Spots and Earth-Magnetic Storms: Rev. W. Sidgreaves.—Watch for the Leonids, 1900, at Markree: F. W. Henkel.—The Diameter of Juno (3), determined with the Micrometer of the 40-inch Refractor of the Yerkes Observatory; with Remarks on some of the other Asteroids: E. E. Barnard.—Observations of the Leonids made at Blackheath, 1900 November 14: E. M. Antoniadi and A. C. D. Crommelin.—The Leonids: Observations at the University Observatory, Oxford: H. H. Turner.—Ephemeris for Physical Observations of Jupiter, 1901: A. C. D. Crommelin.—The System of ζ Herculis: T. Lewis.——*Probable paper*: Observations of Capella as a Double Star with the 28-inch Equatorial of the Royal Observatory, Greenwich; W. H. M. Christie.

MALACOLOGICAL SOCIETY, at 8.—Note on *Bensonia* and an apparently undescribed Species, *B. mimela*: W. T. Blanford.—Note on *Bensonia mainwaringi* and *Macrochlamys dalingensis*: W. T. Blanford.—Further Notes on the British Pliocene Non-Marine Mollusca: A. S. Kennard and B. B. Woodward.—The Anatomy of *Beddomea* and the Relationships of *Amphidromus*: Henry A. Pilsbry.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Power-Gas and Large Gas-Engines for Central Stations: H. A. Humphrey.

SATURDAY, DECEMBER 15.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—Notes on the Mollusc *Paludestrina jenkensi*, Smith, in Essex and elsewhere: A. S. Kennard and B. B. Woodward.—Aquatic Autocrats and Fairies (Lecture): Fred. Enock.

MONDAY, DECEMBER 17.

SOCIETY OF ARTS, at 8.—Electric Oscillations and Electric Waves: Prof. J. A. Fleming, F.R.S.

TUESDAY, DECEMBER 18.

ZOOLOGICAL SOCIETY, at 8.30.—Notes on the Fauna of the White Nile and its Tributaries: Captain Stanley S. Flower.—An Account of a Large Branchiate Polynoid from New Zealand (*Lepidonotus giganteus*, Kirk): W. Malcolm Thomson.—On a New Genus of Flat-fishes from New Zealand: H. M. Kyle.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: The Signalling on the Waterloo and City Railway; and Note on the Signalling of Outlying Siding Connections: A. W. Szlumper.—Signalling on the Liverpool Overhead Railway: S. B. Cottrell.——*Papers to be read, time permitting*: Glasgow Bridge: B. Hall Blyth.—Railway Bridge over the Fitzroy River, at Rockhampton, Queensland: W. J. Doak.—The Niagara Falls and Clifton Steel Arch Bridge: L. L. Buck.

ROYAL STATISTICAL SOCIETY, at 5.—The Statistical Results of the State Monopoly of Spirits, established in Russia in 1895, and its Influence on the Economic Development and Morality of the Population: Alexis Raffalovich.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photography in War: H. C. Shelley.

WEDNESDAY, DECEMBER 19.

GEOLOGICAL SOCIETY, at 8.—On the Igneous Rocks associated with the Cambrian Beds of the Malvern Hills: Prof. T. T. Groom.—On the Upper Greensand and Chloritic Marl of Mere and Maiden Bradley in Wiltshire: A. J. Jukes-Browne and John Scanes.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Seasonal Rainfall of the British Isles: Henry Mellish.—A Review of Past Severe Winters in England, with Deductions therefrom: Albert E. Watson.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A Demonstration of Lantern Projection in Conjunction with the Microscope: Mr. Barton.

THURSDAY, DECEMBER 20.

LINNEAN SOCIETY, at 8.—On the Structure and Habits of the *Ammocharidas*: Arnold T. Watson.—The Flora of Vavau, one of the Tonga Islandx: J. H. Burkill.—Warning Colours in Insects: Prof. E. B. Poulton, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Lecture on the Electrical Engineers (R.E.) in South Africa: Lieut.-Colonel Crompton.

CHEMICAL SOCIETY, at 8.—On the Union of Hydrogen and Chlorine: J. W. Mellor.

FRIDAY, DECEMBER 21.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Use of Geometrical Methods in investigating Mechanical Problems: C. E. Inglis.

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THURSDAY, DECEMBER 20, 1900.

A MODERN SCIENTIFIC INDUSTRY.

Jena Glass and its Applications to Science and Art. By Dr. H. Hovestadt. Pp. xii + 429. (Jena: Fischer, 1900.)

THIS is a volume of some four hundred pages, in which Dr. Hovestadt has collected a mass of information about the Jena glass.

In a report on the scientific apparatus of the London Exhibition of 1876, Abbe called attention to the need for progress in the art of glass making if the microscope were to advance, and to the necessity for obtaining glasses having a different relation between dispersion and mean refractive index than that found in the material then at the disposal of opticians.

He referred to the attempts made in England by Harcourt and Stokes with this object, and to the causes of their failure.

The task thus indicated was undertaken in 1881 by Abbe himself and Schott at Jena. The first catalogue of the Jena Laboratory, published in 1886, contains these words: "The industrial undertaking which is here announced for the first time arose out of a scientific investigation into the connection between the optical properties of amorphous fluxes and their chemical constitution."

The experimental work was only rendered possible by repeated and large subventions from the State. The immediate consequence of the undertaking was that by 1888 nearly all the glass required for optical work in Germany was of home manufacture; in a few years more an export trade in the raw glass began, the value of which in 1898 was over 30,000*l.*, while the value of the optical instruments, such as telescopes, spectacles, field glasses and the like, exported in the same year was nearly 250,000*l.* The trade at present employs some 5000 workmen.

When Abbe and Schott began their work, some six elements only entered into the composition of glasses. By 1888 it had been found possible to combine with these six quantities, up to at least 10 per cent., of twenty-eight additional elements, and the effect of each of these on the refractive index and dispersion had been determined.

Thus, for example, these investigators had found that by the addition of boron the ratio of the length of the blue end of the spectrum to that of the red is reduced; while fluorine, potassium and sodium produce opposite results.

Now an ordinary achromatic lens, uniting two colours of the spectrum, is formed by combining a crown glass lens with one of flint glass having equal total dispersion; but though the total dispersion is the same for the two it is differently distributed throughout the spectrum. In the flint glass the dispersion of the blue end is greater, that of the red less, than in the crown; hence the light from a white source is not white after traversing the lens; a "secondary" spectrum remains, and it was the existence of this which rendered the progress of the microscope so difficult. Abbe's experiments showed how the difficulty was to be met. By combining a high proportion of boron with flint glass, its spectrum became more nearly the same as that of a crown glass. Such a glass had been made by Harcourt many years previously, while a glass containing phosphates instead of silicates is found to have the same dispersion as, combined with a higher refractive index than, the ordinary crown glasses, and therefore serves better to achromatise the borate-flint glass. In fact, Abbe showed that with two such glasses it is possible to combine three colours instead of only two; the outstanding spectrum is greatly reduced in length, and is called a "tertiary" instead of a "secondary" spectrum.

Again, the ordinary microscope lens of two glasses can be corrected for axial spherical aberration for one colour only. Abbe showed that the new borate-phosphate lenses could, by combination with a lens of fluor-spar, have their axial spherical aberration corrected for two colours. These lenses he called apochromatic.

It was found more difficult to reduce the secondary spectrum by lengthening the red end of the spectrum of the crown glass. This required the addition, as we have said, of fluorine, potassium or sodium. The effect of sodium is small; glasses with a large amount of potassium can be made, but are very hygroscopic, while the introduction of fluorine though it was successfully effected, is involved with many difficulties.

The book under review gives, in its first two chapters, an account of the preliminary work of Abbe and Schott, and full details as to the optical properties of the glasses now made. The next four chapters deal with the optical instruments manufactured out of the glasses.

We have already referred to the fundamental improvement in the microscope rendered possible by their use; the problem to be solved in the case of a photograph lens was somewhat different. It follows, from the work of von Seidel, that, with the ordinary crown and flint glasses, the conditions for achromatism and for flatness of field cannot be satisfied together. To do this it is necessary to find a glass of high refractive index and low dispersive power, or *vice versâ*. In ordinary glasses refractive index and dispersive power go together.

Thus, ordinary hard crown glass has a refractive index of 1·518 and a dispersive power of ·0166, while for extra dense flint the figures are 1·717 and ·0339. An achromatic lens might be constructed out of these two glasses, but the field could not be flat.

By introducing barium, however, into the crown glass, a change is produced in this respect. Thus for barium silicate crown the refractive index and dispersive power are 1·573 and ·0173, while for soft crown they are 1·515 and ·0177. With these two glasses, the problem of constructing a photographic object-glass possessing achromatism and flatness of field becomes possible. For the various methods of solution we must refer to the book[1] itself, in which also will be found details as to the use of the glasses for telescopic lenses.

The mechanical properties of glass are next considered, and in Chapter ix. we come to a careful discussion of the imperfect elasticity of glass, specially in connection with thermometry.

[1] See also "Contributions to Photographic Optics," by Dr. Otto Lummer, translated by Prof. S. P. Thompson.

"About twenty years ago" (the quotation is from the catalogue of the German Instrument Exhibition at Paris) "the manufacture of thermometers had come to a dead stop in Germany, thermometers being then invested with a defect, the liability to periodic changes, which seriously endangered German manufacture. Comprehensive investigations were then carried on by the Normal Aichungs-Kommission, the Imperial Physical and Technical Institute, and the Jena Glass Works, and much labour brought the desired reward."

Dr. Hovestadt's account of the labour is most interesting and instructive.

The ice point of a newly made mercury thermometer is known to rise as the thermometer gets older; this rate of rise decreases with the time, finally becoming very slow. If, however, the thermometer be heated to, say, 100° C., and its ice point be taken very shortly afterwards, the reading will be below that observed prior to the observation of the steam point. This depression of the zero varies in amount in different thermometers. It was found (Weber in 1883 and Wiebe 1885–1886) to be specially large in the case of thermometers made of Thuringian glass, amounting in the case of one thermometer examined to 0°·65. As a consequence, the readings of the thermometers were quite uncertain, depending greatly on the past history of the instrument employed. It was this defect which Schott and Abbe set out to cure. Weber had observed that glasses which contained a mixture of potash and soda gave a very large depression. He succeeded in 1883 in making a glass entirely free from soda, in which the depression was only about 0°·1. The work was then taken up by the Aichungs Commission and the Jena factory. A number of thermometers of varying age and manufacture were examined as to the depression, and the glass of these thermometers was then analysed. Weber's conclusions were abundantly verified. An old thermometer of Humboldt's, containing 0·86 per cent. of Na_2O and 20·09 per cent. of K_2O, had a depression of 0°·06; a new instrument, in which the percentages of the two substances respectively were 12·72 and 10·57, had a depression of 0°·65. It is possible that this last thermometer was too new to give quite trustworthy results, but the difference is very marked. An English standard thermometer, with 1·54 per cent. of Na_2O and 12·26 per cent. of K_2O, had a depression of 0°·15, while a French "verre dur" thermometer, with 12·02 of Na_2O and 0·56 of K_2O, showed a depression of only 0°·008.

The next step was to manufacture a German glass with a low depression. The now well-known normal thermometer glass distinguished by the mark 16‴ was the outcome of the experiments. This is a pure soda glass having the following composition:—

SiO_2, 67·5%; Na_2O, 14%; CaO, 7%; Al_2O_3, 2·5%; ZnO, 7%; B_2O_3, 2%,

and the depression observed is 0°·05.

The hydrogen thermometer is, however, the ultimate standard of appeal in thermometry, and it was necessary, therefore, to compare the new instruments with such a thermometer.

Details of the work are given in the book. It appeared, from the results of Wiebe and others, that at a temperature of 40° there was a difference of 0°·12 between the two nstruments. Experiments showed, however, that it was possible to produce a glass agreeing more closely with the gas thermometer than this, and this fact led to further work and to the manufacture of the boro-silicate glass 59‴ with the following analysis:—

SiO_3 72%; Na_2O, 11%; Al_2O_3, 5%; B_2O_3, 12%.

This was found to show a smaller ice point depression, amounting, according to Hovestadt, to 0°·02, and to agree more closely over the range 0° to 100° with the hydrogen thermometer, the difference being greatest at 30°, where it amounts to 0°·038. For temperatures above 100° the differences are considerably greater than those given above, and the agreement between the scales is better for 16‴ than for 59‴.

For details, however, of these comparisons, and of much more work of great interest as to the properties of these special glasses, reference must be had to the book. It constitutes a great record of what is to be achieved by the application of science, that is, "organised common sense" to an important industry. In England we have done nothing to compare with it. As a consequence, Germany can claim that "the manufacture of thermometers has reached in Germany an unprecedented level, and now governs the markets of the world." Such are the results obtained in twenty years by Abbe and his colleagues.

R. T. G.

ESSAYS BY DR. WALLACE.

Studies, Scientific and Social. By Alfred Russel Wallace. 2 vols. Illustrated. (London: Macmillan and Co., Ltd., 1900.) Price 18*s.*

IN addition to being one of the originators of the modern doctrine of animal evolution and one of the leading pioneers in the study of the geographical distribution of the earth's fauna, Dr. Russel Wallace is a writer noted for such a fascinating style and such a happy mode of presenting his views, that any work from his pen is sure of a hearty reception on the part of the more thoughtful section of the reading public. And even those who by no means agree with all his views—whether on scientific or social questions—cannot fail to admire the fairness with which he treats debatable points, and the temperate manner in which he replies to and discusses the objections raised by his critics.

The essays and articles collected in the two volumes before us embrace an extraordinarily wide range of subjects, and cover a period of no less than thirty-five years, the earliest of them being published as long ago as 1865, while the latest saw the light as recently as 1899. The variety of subjects discussed is alone a testimony to the wonderful mental capacity of their talented author, while the number of the periodical publications from which they have been culled bears evidence to the popularity of his writings. Those embraced in the first volume relate exclusively to various branches of geological and biological science, while those in the second are devoted to educational, political, sociological and kindred subjects. With the exception of a brief reference to two articles in the second volume dealing with museums as educational

establishments, our notice will be restricted to the section connected with natural science.

It may be as well to mention, before going further, that in a work dealing with such a variety of subjects as is the case with the one before us, it would be a practical impossibility to review it critically within any reasonable space; and we must accordingly content ourself with a brief survey of its principal contents.

Quite apart from the general interest of the book, as dealing with some of the most important biological and social topics of the day, there can be no question that, from the point of view of the working naturalist, the author has been well advised in publishing the essays of which it is composed in a collective form. Several of them are replies to criticisms on some of Dr. Wallace's views, while others, such as the one on the affinities and origin of the Australian and Polynesian races, contain entirely new views and theories. Before their publication in their present form it was, consequently, exceedingly difficult for a writer on any particular zoological subject to be sure that he had seen Dr. Wallace's last words on that subject. Indeed, the writer of this notice feels that he owes an apology in that, when writing an essay in favour of the Caucasian affinities of the Australians, he was unaware that Dr. Wallace had previously urged the same view. In one respect, the omission may perhaps be regarded as fortunate, as it permitted the same conclusion to be reached independently.

From the fact that some of the articles are more or less recent while others are of considerable antiquity, it will, of course, be evident that they have by no means all an equally important bearing on disputed questions of the day. The one on the evolution and distribution of animals, for example, dates from the early days of the study of that subject, whereas that on the distinction between the Palæarctic and Nearctic regions deals with a proposed amendment of the author's classification.

The first five essays deal mainly with the agencies that have modified certain parts of the surface of the globe, the alternations that have taken place in the distribution of sea and land, and the state of the interior of the globe. In the main, Dr. Wallace is a strict uniformitarian, and his account of how even the deepest and steepest mountain valleys have been eroded by the ordinary denuding agencies will be read with interest. He is fully convinced of the important part played by ice in the modelling of the earth's surface during the Pleistocene period, and pays no heed to the arguments that have been urged of late years against the former existence of an ice age. Whether his adherence to the theory of the erosive action of ice as the dominant factor in the formation of lake-basins will commend itself to many modern geologists may be doubtful; and the denial by some that such a thing as a true rock-basin exists would, if fully confirmed, to a great extent annul several of his arguments.

In the essay on the permanency of ocean-basins the author, in the main, pleads in favour of his original views, and offers some objections to the theory of large continental and ocean changes which demand respectful and serious attention on the part of those who differ from him in this respect. Nevertheless, in granting the possibility that such alternations of sea and land may have extended to such parts of the ocean as lie approximately within the limits of the two thousand fathom line, he has conceded much that is demanded by his opponents. Indeed this extension of the limits (formerly fixed at the 1000 fathom line) would practically admit of a land connection, at least by way of Antarctica, between South America and Africa, if not also between South America and Australia. And to learn how strong is the evidence in favour of such connections, the reader need only consult the paper recently read by Prof. Scott before the British Association.

Among the essays on descriptive zoology, attention may be confined to the one on monkeys and their affinities, which originally appeared (without the illustrations) in the *Contemporary Review* for 1881. It is an interesting and well written survey of the leading groups of these animals, in the course of which the author raises the question whether the Primates, other than man, are rightly regarded as the head of the animal kingdom. In this article, as in several others, we think it a pity that the author has not seen fit to adapt his nomenclature to that now current among systematic zoologists, and that he clings to such discarded names as Cynocephalus, Mycetes and Cuscus. Moreover, we notice on page 156 the misprint *babuino* for *babuin*; and we venture to affirm that the statement on the following page to the effect that the mandrill in size and strength is not much inferior to the gorilla is scarcely consonant with the facts—certainly not so far as size alone is concerned.

Of the articles on geographical distribution, two deal with North American flowers and trees and their differences from those of Europe, a third treats of the beetles of Madeira and the inferences to be drawn from them, while to the other two a brief reference has been already made.

Five essays are devoted to the theory of evolution, among which special attention may be directed to the one dealing with the question of the possibility of acquired characters being inherited, which appeared in the *Fortnightly Review* for 1893. At the conclusion of this article Dr. Wallace remarks "that no case has yet been made out for the inheritance of individually acquired characters, and that variation and natural selection are fully adequate to account for those various modifications of organisms which have been supposed to be beyond their power."

To many readers the three essays on anthropological subjects will perhaps prove the most interesting in the whole book. The first of these deals with the Polynesians and their migrations, the second gives an account of New Guinea and its inhabitants, and the third treats of the affinities and origin of both Polynesians and Australians. In the title of the second member of this trilogy the author has scarcely done himself justice, since, in addition to describing the Papuans, he gives a most interesting summary of the leading features of the mammalian and avian fauna of the largest island in the globe. The illustrations of some of the recently discovered types of birds of paradise in this article are among the most exquisite examples of photogravure that have come under our notice. Well selected, too, are the anthropological photographs with which these articles are illustrated, and especial attention may be directed to the juxtaposed portraits of an Australian

and a Yeso Ainu, which the author considers afford important evidence in favour of the Caucasian affinities of the former race. Mr. Wallace, in opposition to the views of the late Sir William Flower, likewise advocates a Caucasian descent for the brown Polynesians. The use of the bow and arrow by the Papuans, and not by either the Australians or the Polynesians, is, he remarks, a notable ethnical fact. It clearly, indeed, serves to differentiate the Australians from the Papuans and other Melanesians; but then, on the other hand, it might also be used as an argument that the Polynesians are related to the Malays, who likewise never use the weapon in question. It may be remarked as somewhat strange that, when the author alludes to the possession of the boomerang by races other than the Australians, he omits to mention its use by certain Indian jungle tribes.

With one article on the problem of instinct, and a second on human selection, the latter worthy the best attention of those interested in the well being and improvement (both physically and morally) of the human race, the first of these two most interesting volumes is brought to close.

In the second volume our remarks, as already said, will be restricted to the first two articles, one of which deals with how an ideal zoological museum should be constructed and arranged in the best manner for educating the public, while the second discusses how near an approach to this ideal is made by the museums of the United States. The author seems to be clearly of opinion that a most important, if not, indeed, the prime function of a museum should be as an educating medium. In his main ideas he is in accord with the opinions of the late Sir William Flower, and he points out that a perfect museum ought to embrace everything from the lowest worm to the highest product of human art and skill. He also advocates the exhibition of a comparatively limited number of specimens (which should be the best that money can obtain), in order not to confuse by multitude, and also that these should have ample space. The allotment of separate chambers to particular groups is likewise made a point, because, as he urges, a long gallery only serves to distract the attention of the visitor from the objects immediately before him to those ahead, and thus inevitably leads to hurry and an imperfect study. Lastly, but not least in importance, Dr. Wallace advocates the arrangement of zoological collections according to local faunas, instead of according to the affinities of the animals themselves.

Whether or no this faunistic arrangement should be adopted for the main exhibited series in a museum may be an open question; but there can be no question at all that such an arrangement should be displayed in every national museum. The American Museum of Natural History shows in one case the animals living within a fifty-mile radius of New York, and in a second the characteristic members of the European fauna; and nothing of this nature can be of higher educational value. With regard to limiting the number of specimens exhibited, a difficulty occurs, since a museum—at any rate in England—has at least two distinct classes of visitors for whom to cater. For the ordinary lover of natural history, as well as for the general zoological student, to say nothing of "the man in the street," a small number of specific representatives of various groups is not only sufficient, but forms the best kind of exhibit he can be shown. On the other hand, although the working zoologist will find what he requires in the study series, the sportsman—and in Britain his name is legion—expects to find exhibited every species and race of furred and feathered game he may encounter in the course of his wanderings. To find a *via media* out of this difficulty is a problem which will probably long continue to vex the mind of the museum curator; but, like other difficulties, it will one day have to be faced and conquered.

Our best wish to the many readers whom Dr. Wallace's two volumes will undoubtedly attract is that they may derive from their perusal an amount of interest and instruction equal to that which has accrued to the present reviewer in the accomplishment of his task.

R. L.

BRITISH BRAMBLES.

Handbook of British Rubi. By William Moyle Rogers, F.L.S. Pp. xiv + 111. (London: Duckworth and Co., 1900).

MR. ROGERS' "Handbook of British Rubi" is not a work likely to excite a wide interest. As the offering to his fellow "batologists" of "a diligent student of British brambles for nearly a quarter of a century," it appeals to a restricted circle. No general worker in the field of systematic botany can hope to master the fine distinctions which discriminate the great majority of the so-called species; in fact, the general systematist will see at once that the batologist and he are widely at variance as to the limitation of species, and that for purposes of comparison with those of other genera and of a comparative study of floras the 'species' of British Rubi are useless. Generally speaking a 'species' is to some extent a personal matter, sometimes varying considerably in different conditions of one and the same person; but the entities recognised by several workers in one group usually bear an appreciable relation to each other and to those of other groups. It is not too much to say that there is no comparison whatever between the species of the batologist and the species of the botanist.

In Sir Joseph Hooker's "Student's Flora," which we may regard as the expression of the views on the British flora of our greatest living systematist, four species of *Rubus* are recognised, namely, *R. Chamaemorus* (the cloudberry), *R. saxatilis*, a small low-growing, sub-alpine plant rare in the south and east of England; *R. Idaeus* (the raspberry), and *R. fruticosus* (the blackberry or bramble); under the last-named twenty-two forms or subspecies are enumerated. Bentham, in his "Handbook of the British Flora," has five species, *R. caesius* (the dewberry) ranking as a species, whereas in the Student's Flora it is regarded as a subspecies of *R. fruticosus*. Babington, whose manual is generally recognised as the best critical account of our flora, and who paid some attention to the *Rubi*, makes forty-eight species by raising to specific rank a number of forms of *R. fruticosus*. Mr. Rogers, by a further elaboration of the same species, admits one hundred and three, many of which are subdivided into subspecies or varieties.

Thus *R. anglosaxonicus* has four subspecies and *R. dumetorum* eight varieties, and of the latter Mr. Rogers says,

"Other undescribed forms of this aggregate no doubt exist in Great Britain, and a further study of these may possibly justify the addition of one or more new varieties to the preceding list."

Thirteen of the species and a fair proportion of the varieties and subspecies are peculiar to the British Isles, occurring mainly in very restricted areas. *R. durescens*, for instance, is known only in Mid-Derbyshire, and *R. mercicus* is "at present known with certainty only between Water Orton and Minworth, Warwickshire."

We do not wish to underrate the value of the work of Mr. Rogers and his fellow-batologists, who, moreover, are not wholly responsible for the present state of batology. They are disciples of Dr. W. O. Focke, of Bremen, whose epoch-making visit to England in 1889 is referred to almost as the missionary visit of an apostle. The handbook is a monument of patient toil and critical examination; each species, subspecies and variety is described with a care and fulness which many botanists would do well to emulate; notes on habitat are given, the distribution, if any, on the Continent is recorded, and there are also many remarks of a critical nature on the affinities of the form in question. An appendix contains a list of the botanical counties for which each species is recorded; and the thorny path of the student is somewhat eased by a key to the groups and a brief conspectus of the species which precede the detailed descriptions.

As a study in the variation of a highly variable species, the book is a store of valuable information, which, if carefully collated and arranged, might yield results of great interest, especially if more particulars as to habitat and environment were included. However, Mr. Rogers' aim has been to record and systematise, for the benefit of students of batology, facts already ascertained, and he has carried out his task in a manner which, except for a few details, is beyond criticism, and calls for the gratitude of all batologists present and to come.

A. B. R.

EXPERIMENTAL FRUIT-FARMING.

Report of the Working and Results of the Woburn Experimental Fruit Farm. By the Duke of Bedford and Spencer U. Pickering, F.R.S. Second report. Pp. v + 260. (London: Eyre and Spottiswoode. 1900.)

IN few departments of plant cultivation is empiricism more rampant than in the cultivation of fruit-trees. The methods of pruning and other cultural details have been handed down from our forefathers with little or no attempt to regulate them by scientific methods, whilst, in too many instances, absolute neglect has prevailed and fruit-growing has, in consequence, been deemed unprofitable at the very time when thousands upon thousands of barrels of apples are imported annually from the United States, Canada and Tasmania. In some cases this foreign supply comes in when our own crop is exhausted, but, speaking generally, a very large proportion of the fruit crop might be grown here just as well as in the States were our farmers endowed with the same business capacities as their brethren across the Atlantic. Recognising the importance of these facts, the Duke of Bedford has established near Woburn an experimental fruit-farm, where, under the directions of Mr. Pickering, experiments are being carried out on various cultural methods applied to fruit trees and to bush fruit. At the same time, demonstration plots are planted with a view of showing to the farmers what kinds of apples and other fruit trees may be grown in that particular locality with a reasonable expectation of profit.

The farm has now been established for five years. The first report, published three years ago, was naturally devoted largely to a general account of the ground and of the experiments then commenced. The present volume deals more largely with results. Those who have no leisure to investigate the statistical details will be able to glean a good general idea of their purport from the perusal of the table of contents and the general summary given in the appendix.

The experiments made with a view of destroying the currant-bud mite were very numerous and very unsatisfactory. Although at Wye College the use of hydrocyanic vapor has been found serviceable, it was found of no avail at Woburn. It would seem, however, that our efforts will be negative until we know more of the life-history of the mite. Perhaps the study of the manners and customs of the hazel-bud mite might furnish a useful clue to our knowledge of the nearly allied currant-bud mite.

Eighty-five varieties of strawberries were under observation, but it was not found possible to trace any definite connection between the amount of the crop they furnished and the meteorological phenomena to which the plants were subjected. Moreover, the results of the application of manures, artificial or natural, are stated to be "ambiguous," a fact which points to the inference that the soil is sufficiently fertile without the application of manure.

The results of pruning at various times and of differen methods of performing the operation are tested by weighing a certain number of leaves from the trees, and by measuring the height and girth of the trees. From these experiments, it would seem as if further time is required to estimate the value or otherwise of the different methods of pruning. Root pruning, a practice largely adopted by gardeners to check undue luxuriance and promote fertility, is made the subject of other experiments by Mr. Pickering and his lieutenant, Mr. Castle. Although root pruning acts as a check to vegetation, it generally also results in the formation of a large quantity of fibrous roots and root-hairs, so that the absorbent power of the roots must be increased, and we might have expected the vegetation to be correspondingly enhanced. There is a little inconsistency here which we hope the Woburn experiments may ultimately clear up.

Perhaps the most striking result yet obtained is that showing the injurious effect of growing grass round the fruit trees, the injury being attributed to the increased evaporation from the soil and the consequent exposure of the trees to drought. Many of our orchards are in grass, but as they are "fed off" by sheep the injurious results may, in a measure, be counteracted by the manure so supplied. Other experiments we can not here further allude to, but, in conclusion, we can but emphasise the

great importance of the experiments which are carried out by the munificence and public spirit of the Duke of Bedford. Each year their value and importance will be enhanced. If we might make one suggestion it would be that a corresponding series of experiments, though not necessarily on so large a scale, might be made on barren sand or some soil less naturally fertile than that at Ridgmont. MAXWELL T. MASTERS.

OUR BOOK SHELF.

Design in Nature's Story. By Walter Kidd, M.D., F.Z.S. Pp. ix+165. (London: James Nisbet and Co., Ltd., 1900).

HUXLEY pointed out that the Darwinian theory of adaptations was incompatible with "the commoner and coarser forms of teleology," but admitted that "there is a wider teleology, which is not touched by the doctrine of Evolution." But Dr. Kidd is not satisfied with this, and has written a little book to protest against the attempt of modern science to ignore what is called "Design in Nature." He does not trouble himself to define with any precision what he means by this phrase, but he seems to mean what is called "the directive intelligence of a personal God," and we can only repeat what has been said so often, that with this the scientific mood, as such, has nothing whatever to do, though it supplies some of the data with respect to which the philosophic mood may decide as to the validity and fittest formulation of the conception. When Weismann says, to the author's disgust, that the introduction of teleological principles is the ruin of science, he simply expresses the general conviction that their introduction is incongruous with the scientific method. Dr. Kidd does not seem to see that to oppose scientific and teleological interpretations is to oppose incommensurables.

The author gives examples of adaptations in plants, in animals, and in man, but Darwin's illustrations are far more convincing. He emphasises also "the adaptedness of environments for coming organisms," though it seems plain enough that only those organisms could come to stay who were relatively fit to survive in the given conditions. If the author will reconsider, for instance, the position expressed by W. K. Brooks in his "Foundations of Zoology," he may discover that he is tilting against a windmill, that Darwin did at least as much for teleology as Paley, and that our provisional theories of the rise and progress of adaptations suggest no reason whatever why the philosophers should not adhere to the teleological position. But these discoveries should have been made before publication. J. A. T.

Penrose's Pictorial Annual. Vol. vi., *The Process Year-book for* 1900. Edited by William Gamble. Pp. xvi +112. (London: Penrose and Co., 1900).

THIS handsome volume will give the reader an excellent idea of the way in which photographs *can* be reproduced for illustration purposes. It is too often the case that either copies of photographs have to be made quickly or the paper on which they are printed is not of the most appropriate kind, so that the "reproduction" is by no means of a very high order. In this annual, however, the editor has taken great care that the art of reproduction should be given its full scope, and any reader cannot but admire the results as here displayed. From the beginning to the end of the volume we find innumerable illustrations, dealing with all kinds of subjects and reproduced by nearly as many processes. The illustrations are as nearly perfect as reproductions can be, and show that a sound practical knowledge has been utilised throughout. The editor states that "We have tried to show what photomechanical processes can do at the present time, and to present the specimens of the numerous British and foreign firms in a style which will bring out every quality in the plates." That this has been carried out in a highly satisfactory manner cannot be denied.

Many hints may be gathered from the numerous articles scattered throughout the volume, especially from that written by the editor on catalogue illustrations.

In conclusion it may be stated that every one interested in the subject of process work, and who wishes to know its position to-day, cannot do better than examine closely the examples displayed throughout the pages of this volume, which is a model of good printing and get-up.

Knowledge Diary and Scientific Handbook for 1901. (London: *Knowledge* Office, 1900.)

THIS publication is one which appeals more particularly to those interested in astronomy, and will doubtless prove a great convenience to actual observers for recording their observations, and to others for use as a private diary. There is a generous allowance of space for each day, and provision is made for recording correspondence. In addition, there are 120 pages of printed matter, consisting of the principal astronomical data for the year, a calendar of notable events, a variety of useful tables, and reprints of a few articles of more than passing interest which have appeared in *Knowledge.* Star maps, showing the aspect of the heavens for each month, are also given. As the recognition of the planets is apt to be a source of difficulty to beginners, it would be well in future issues to state the times of their rising and setting as well as of their southing, and to indicate their places month by month in connection with the star maps.

A Short Course of Elementary Plane Trigonometry. By Charles Pendlebury. Pp. xi+160. (London: George Bell and Sons, 1900.)

THIS short course is intended for those who do not require more than a very elementary knowledge of the subject. The treatment adopted is therefore very simple and the language plain. The book is divided into four parts. The first includes definitions, trigonometrical ratios, and multiple and sub-multiple angles, &c.; the second contains a short account of the use of logarithms and mathematical tables. In the third part the solution of triangles, determination of areas of triangles, and the treatment of circles and other figures associated with a triangle are dealt with. Part iv. contains the solutions of some of the more simple trigonometrical equations and also numerous questions on bookwork and answers to the many examples given in the book. As a first course for beginners the book should prove useful.

Lehrbuch der anorganischen Chemie. Von Prof. Dr. H. Erdmann. Zweite Auflage. Pp. xxvi+757. (Brunswick: Viewig und Sohn, 1900.)

THE first edition of this book, published two years ago, was noticed in these columns at some length. The present edition does not materially differ from it, but numerous additions of detail have been made in order to bring the book up to date. Conspicuous among these additions is information about the new gases—here called Edelgase, presumably from their relegation to Mendeleef's seventh group. A fine chromo-lithograph of the spectra of the gases has been added. If there is a want of connectedness and philosophy in Prof. Erdmann's book, there is certainly an abundance of interesting detail collected from a wide field, and on this must lie its chief claim to recommendation.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Chemical Products and Appliances at the Paris International Exhibition.

I SEE that attention has been called in these columns to the excellence of the German catalogue of instruments of precision distributed at the recent Exhibition. It will be of interest if, as a member of the jury representing Great Britain for Class 87, I may be permitted to add that the German catalogue explanatory of the collective chemical exhibits of that country is also a remarkable production, worthy of a permanent place on our library shelves. Copies of this work, printed and got up in a highly artistic way with German text, were distributed among the members of the jury by my friend, Geh. Rath. Dr. Otto N. Witt, the titular member representing Germany on our jury. A French edition was afterwards to be had on application to the custodian of the German exhibits. The work consists of over 200 pages, each embellished with a coloured floral design as a heading, and contains a general introduction, giving an account of the development of German chemical industry, the value of the production in this branch of manufacture for the year 1897 being estimated at 47,395,132*l.* (947,902,645 marks). The introductory part, which is from the pen of Dr. Witt, is followed by a special part containing the history, an account of the nature of the products manufactured, the equipment of the factory and scale of production, and a list of the exhibits of each of the ninety firms represented in the collective exhibit. Those who visited the Exhibition and made an examination of the chemical exhibits of the various countries will have formed their own conclusions as to their respective positions in the scale of chemical industry. At any rate, it is not the object of this letter to institute invidious comparisons—I merely wish to point out that it is not only in instruments of precision that the German catalogue reveals the industrial eminence of that country.

R. MELDOLA.

Electricities of Stripping and of Cleavage.

IN the ordinary process of giving a glazed surface to photographic paper prints by leaving them to dry face downwards upon clean glass, enough electricity is, I find, developed at the moment of separation between the dry glazed print and its glass support to produce a pretty bright illumination in the dark. "Solio" and other gelatino-chloride printing papers being very liable to adhere obstinately to a glass plate in this process, I have only constantly employed it with albumenised printing paper, and have then often noticed strong electrical attraction between the glass plate and the freshly separated paper. Not all glass plates, but apparently only very hard unhygroscopic ones, with a low percentage of soda in their composition, serve the purpose well; and even on these the print must not be freed from superfluous water by any pressure, but by swinging the plate until the water is sufficiently expelled to leave the glass and paper adhering firmly to each other. The paper can be then further freed from water by wiping it on the back, very lightly, with a soft cloth, and any intrusive air-bubbles seen through the glass can be driven out by stroking the back of the print very lightly with the finger. Left then to dry quite horizontally with the paper upwards, the latter will in hot, dry weather or in a very dry, warm room separate itself at last more or less completely from the glass; but in ordinarily damp atmosphere, and cold weather, remains, though sensibly quite dry, adhering to it. The slightest warmth of sunshine or of a fire or gas flame applied to the plate is then enough to make the paper crisp, and leave the glass. This it does with audible clicks as the adhesion breaks up here and there, showing that a state of pretty strong tension prevails in the thoroughly dry paper and the coat of albumen until these can break loose from their support.

The tension is apparently strongest in the albuminous coating of the paper, since the paper curls in towards that face when it is liberated; and if the process of separation is observed on the face of the print, through the glass, the still adhering white parts of the paper have a greenish, and the loosened parts the ordinary yellowish tinge of such papers, in very perceptible contrast with each other. When well dried spontaneously in a warm, dry place, if, also, the rough back of the dry paper is rubbed smooth before gently warming it to strip it off, there is strong enough electrical attraction between the glass and the released paper to keep the latter flat against the glass while the separation spreads, with clicks and snaps of freeing from the edges, until soon, the tension in the film prevailing, the glazed and loosened print bulges upwards in the middle and its ends curl inwards. In the drum-like shape which it then sometimes assumes I have seen it rolling about on the under side of the warm glass plate, supported there for some minutes by the mutual electrical attraction between the dry paper and its glass support.

After trying in vain, for some months past, to see any luminous signs of this strong electrification, by taking the warmed plate when separation was commencing, into an adjoining darker room to watch the operation's progress, to-night, at last, the experiment has perfectly succeeded. The conditions in which it did so were not exceptionally favourable ones in any particular respects that I could notice, but a quickly toned, fixed and washed albumen paper print had dried slowly and thoroughly in a dry, warm place without loosening itself from the glass surface. The paper was not smoothed on the back before holding it pretty close to the dull hot coals of a low fire, which had scarcely time to more than slightly warm it, when clicking sounds announced that splitting from the glass surface had commenced.[1] A glance through the glass face showed that loosening from the glass at one end of the print had just begun, and the plate was immediately taken, for the paper to finish freeing itself, into perfect darkness in another room. Though but very slightly warmed, a little waving of the plate, with its transparent glass side upwards, up and down (which assists the parting by rapid drying and changes of temperature in the paper), presently advanced the cleavage a little step further, and this was marked by an audible snap, and at the same time by a light-flash at the released end of the print, bright enough to have been seen easily by sufficiently watchful eyes, from any part of the moderately large room. The same bright glow followed the line of yielding of the print, while it was then quickly seized by its loose end and stripped from the under side of the glass plate by hand, as a yellow or orange-coloured stripe of gauzy light, about half an inch wide, as bright as the first flicker of whiter gauzy light.

Considering that the tough coating of dry albumen seems to be stretched on its glass support with considerable strain and force of tension, which is slackened and released immediately behind its advancing line of severance from the rigid glass, perhaps the electric excitation may be due to friction of small rubbing surfaces of the loosened coat of albumen against the glass; and in that case the example may be one of electrification by a mechanical, rather than by a molecular form of cleavage like that observed in crystals, of one surface from another. In Becquerel's well-known experiment of the evolution of electricity and light when a thin lamina of mica is split into two thinner leaves, no definable forces of released tension, leading to electrification by friction of dissimilar portions of the crystal, can be resorted to as probable effective working sources in the mica, or in other crystals, of the electricities developed by their cleavage. But while no evident condition seems, in fact, to predetermine which of the two halves of a split leaf of mica should be found to receive a positive and which a negative charge from the electrifying forces which the cleavage exercises, the common experience that glass rubbed with silk is positively, and the silk negatively, electrified in a determinate and certain way could easily afford a test, and might furnish some assurance of the sufficiency of the above view's account of the origin in mechanical friction of the glass's and paper's opposite electrifications, if the two bodies, stripped asunder, are found to be endued with electrical charges of invariable kinds agreeing with those which glass and dried white of egg acquire when they are rubbed together. But I have not yet had an opportunity of putting the question to this test by the simple use of an electroscope, although the experiment could be easily performed with that appropriate equipment as the persistency of the charges on the glass and on the paper is plentifully long enough to allow of their complete investigation.

[1] These sounds are chiefly due to tough adhesions common at ragged points along the paper edges, and overcome from time to time by the spreading separation and increasing tension. Across the open print surface the separation spreads silently and smoothly, except across occasional spots of softened albumen with unduly tough adhesion, which may also there sometimes occasion snapping sounds in parting.

The momentary gleams of the electric light-play can be very easily observed by holding an albumen paper print thoroughly well self-dried on glass, paper side downwards, in a perfectly dark room over a hot room-stove to produce the paper's separation, and by stripping the print off downwards as soon as some edge of it has grown loose enough—probably with some signs of light—to allow it to be taken in the fingers. I have by this means now seen those brush and glow lights' flitting beams a second time, and there seems to be no difficulty of producing them in varied form and brightness by this method of proceeding. A. S. HERSCHEL.

Observatory House, Slough, December 10.

Photography of the Static Discharge.

The accompanying photograph of the spark of a large static machine may possibly be of some interest to the readers of NATURE. The machine is a large Holtz, used in the electrical department of St. Bartholomew's Hospital. It consists of eight glass plates of twenty-nine inches in diameter, inclosed in a glass case. It is driven by a motor which is worked by the 100 volt alternating main which supplies the electrical department with its alternating current. The initial charge is obtained from a small Voss machine which is inclosed in the case of the Holtz. The photograph was obtained in the following manner. The machine was started and the brass knobs of the conductors adjusted to give a spark of about seven inches in length. The knobs were now tested in the usual way (by presenting a metallic point to the conductors) with reference to the

sign of their charge. A gelatine dry plate was then taken, inclosed firstly in an orange and then in a black envelope. The plate was placed between the knobs of the conductors in a line parallel with them and the sparks allowed to play over the envelope for a period of one second of time. The plate was then taken to the dark-room, developed and fixed in the ordinary way. The accompanying illustration shows the curious results obtained. A distinct break can be seen in the continuity of the sparks between the positive and negative poles. Round the positive pole the sparks are rushing off in a dense mass with a direction from the negative pole of the machine. At the line of separation of this dense mass of sparks is seen a depression as if the mass had been eroded by the negative charge, reminding one very forcibly of what happens to the positive carbon of the arc light. At the negative pole the sparks are much less dense and more fan-shaped, and radiate in the reverse direction to the positive sparks with the exception of a cone of sparks, which are much smaller, which approach the depression in the positive mass. This prolongation of small sparks towards the positive pole is seen in each of the photographs obtained. The results of the experiment are curious. I am unable to explain them, but think they are perhaps worthy of record.

St. Bartholomew's Hospital. HUGH WALSHAM.

Malaria and Mosquitoes.

As I was reading the very interesting article by Dr. Fielding-Ould on the "Malaria Campaign," which appeared in NATURE of November 8, I was struck by the fact that the use of the mosquito-netting he suggests as an efficacious preventive against malaria fever was already arrived at several years ago through nothing but experience in one of the malaria districts in Syria. The following is a translation of a letter published in vol. viii. (April 1884) of the *Muktataf*, an Arabic literary and scientific review, edited in Cairo, Egypt, by Drs. Sarrûf and Nimr:—

"To the Editors of *Al-Muktataf*.

"GENTLEMEN,—I have already had the chance of observing the spread of the malaria fever in Rashiya, both in the autumns of 1878 and 1883, and I noticed that one of the principal agents in effecting its spread was the mosquito. I have also noticed that all those who, at the time of the epidemic, took precautions against the mosquito bites escaped the fever, a fact well known in this part of the country. I therefore conclude that mosquito nets which completely cover the bed and prevent the entrance of mosquitoes are the best fever preventives in countries abounding in malaria marshes.

ABDELLA JABBOUR,

Rashiya.

Trusting the above will find a place in your esteemed paper,

N. Y. SARRÛF.

Cairo, December 7.

Can Spectroscopic Analysis Furnish us with Precise Information as to the Petrography of the Moon?

THEORETICALLY I think we may reply in the affirmative, but whether our means of observation are, as yet, delicate enough to give give us trustworthy results I leave to the investigation of your readers.

As the question is of considerable interest, pardon me if I enter somewhat into detail.

(1) If we had two smooth, plane, parallel mirrors, perfectly elastic, and a gas jet midway between them, we might first light the gas and then extinguish it without destroying the illumination, for, if the mirrors were perfectly elastic, the waves of light would oscillate between the two for ever with undiminished intensity. We know that this is not the case, therefore no known substance is perfectly elastic.

(2) If direct solar light fall upon a large mass of sandstone, part of it penetrates the mass as heat, and part is reflected, with a diminished velocity, so that we might expect, *a priori*, an apparent displacement of the Fraunhofer lines, as compared with the spectrum of direct sunlight.

(3) Similar results might be looked for with regard to limestone, basalt, &c., but not identical, unless we make the very improbable supposition that all solids are equally elastic.

(4) Hence it should be possible to construct a table of relative photo-elasticities so that if the substance were given its elasticity might be found by inspection, and *vice versâ*.

(5) Next, analysing the sunlight reflected from various regions of the moon, and referring to our table, we might hope for answers to the questions

(α) Are Tycho, Copernicus and the Appenines basaltic?

(β) Is the Mare Tranquilitatis the dried-up limestone bed of a saltwater ocean, or the dried-up sandstone bed of a freshwater inland sea?

I admit, at once, that the observations suggested are of extreme delicacy, but I cannot consider them insurmountable in an age which has witnessed the proof of the regression and subsequent approach of Sirius to the solar system by this very method. W. J. KNIGHT.

Cork.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

AT the International Conference which met in London last June to discuss this subject, it was thought that the time had arrived when the great work of publishing a complete catalogue of all the scientific literature of the world might be undertaken with every prospect of success.

A Provisional International Committee was, therefore, appointed at the Conference to carry out the preliminary work, and this Committee reported the results of its labours to an International Council which met last week in the rooms of the Royal Society.

At this meeting, which took place on December 12 and 13, there were present:—Prof. B. Schwalbe, representing Dr. Milkau (Germany), Prof. G. Darboux, representing Prof. H. Poincaré, and Dr. J. Deniker (France), Prof. A. W. Rücker, Sir M. Foster, Prof. H. E. Armstrong and Dr. L. Mond (Great Britain), Prof. J. H. Graf (Switzerland), Dr. E. W. Dahlgren (Sweden), Prof. Korteweg (Holland), Dr. M. Knudsen (Denmark), Mr. Roland Trimen (Cape Colony), Dr. W. T. Blanford (India), Señor del Paso y Troncoso (Mexico), and M. Metaxas (Greece). Dr. Ludwig Mond represented Italy in the absence of Prof. Nasini. Sir Michael Foster was elected chairman of the meeting.

It is proposed that the annual cost of a set of seventeen volumes shall be 17*l*., and on this basis it was announced that the number of sets subscribed for by the various countries was as follows:—

	Sets.
United States of America	68
Great Britain	45
Germany	45
France	35
Italy	27
Japan	15
Switzerland	7
Sweden	6½
Denmark	6
Holland	6
Norway	5
Mexico	5
Cape Colony	5
Canada	4½
Hungary	4
Portugal	2
South Australia	2
Western Australia	1
Victoria	1

One great difficulty in starting an enterprise of this magnitude is that a large amount of capital is needed to cover the preliminary expenses and to pay for the printing of the first set of volumes, and for other work which must be done before the grants from the various countries are received, and before any sales of the volumes to the public can be effected. This initial difficulty was met by the Royal Society, which generously offered to advance the necessary capital. This offer was accepted by the International Council, which expects to be in a position to repay the sum advanced during the next few years.

The Royal Society offered to act as the publishers of the catalogue, and to sign the necessary contracts with the printers and publishing agents. This offer was unanimously accepted by the International Council, which, after carefully examining the clauses of the proposed contracts, declared its approval of them.

The three principal countries which have not yet joined in the scheme are Russia, Belgium and Spain; and the Royal Society was asked by the International Council to address the Imperial Academy of Sciences of St. Petersburg on the subject, and also to take steps to induce the other countries to join in the catalogue.

A code of instructions for the use of all who are taking part in the preparation of the catalogue was considered, and, after some amendment, adopted.

In this connection the chief point discussed was whether it is desirable to publish complete lists of new botanical and zoological species. It was decided that lists of new species should be published, and that they should, as far as possible, contain all the additions to our knowledge in this direction made within the year.

It was also decided to include translations in the catalogue, but to indicate that they are translations. Schedules of classification for the subject indexes of the several sciences were adopted.

An executive committee was appointed, consisting of the four delegates of the Royal Society and the representatives of the four largest subscribers to the catalogue—France, Germany, Italy and the United States. Dr. H. Forster Morley was appointed director of the catalogue.

Finally, it was resolved to begin the work on January 1, 1901, and to include in the catalogue all literature published after that date.

FURTHER REMAINS FROM LAKE CALLABONNA.[1]

THE undermentioned Memoir is the second of a series, dealing with the remains of the great extinct vertebrates discovered in the Lake Callabonna in South Australia during the expedition already commented upon in our pages (NATURE, vol. lxi. p. 275, 1894), and now famous for having yielded the materials for a fuller knowledge of the osteology of the remarkable marsupial, colossus Diprotodon. The present contribution deals entirely with the great flightless bird Genyornis, which was found in association with this, and is for the most part an extended and illustrated account of portions of its skeleton, which the authors have already more briefly described in the Transactions of the Royal Society of South Australia and elsewhere. It is divided into two parts, a first dealing with the bones alone, a second containing an account of the surroundings and physical features of the Lake and the characters of its bed, of its geology, and the history of its investigation, all of which are special and detailed, and have for the greater part received prior consideration in our pages in the aforementioned article and in its predecessors therein referred to by the authors themselves (NATURE, vol. l. pp. 184 and 206), permission to quote freely from which they herein acknowledge.

It is with the first part of the Memoir we are chiefly concerned, and the newer facts it sets forth are the outcome of the results of comparison with the numerous remains described of those of allied genera mostly preserved in the Australian Museums. In dealing with these the authors pay a just tribute to the work and energetic enthusiasm of Mr. R. Etheridge, junr., the indefatigable curator of the Sydney Museum, whose Memoir on the subject in the "Records of the Geological Survey of New South Wales" is taken as the basis of their inquiry; and, as the outcome of this portion of the work, they have been led to associate with the Callabonna genus certain skeletal fragments, previously collected in South Australia, Queensland, and New South Wales, of Pliocene and Pleistocene age, especially a portion of a tibia from Mount Gambier, of a femur and some tibiæ from Normanville, of a tibia from the Paroo River, and of a fragment of a pelvis from the Canadian Gold Lead in New South Wales, most of which had been referred by Owen and Etheridge, junr., to the genus Dromornis.

The generic name Genyornis is expressive of the great size of the lower jaw, and a fuller description of this is, we presume, reserved for a promised detailed memoir in course of preparation. The present one treats mainly of the limb-bones, shoulder girdle and sternum, and the most noteworthy facts recorded are the numerical reduction of the phalanges of the outermost (fourth) digit to four, and the great slenderness, indicative of reduction, of the innermost or second, which, for the Ratitæ, are exceptional features. These characters notwithstanding, the authors, from a careful study of the measurements of the long bones and particularly of all that concerns the sternum, which is here for the first time fully described, regard the Emeu as the nearest living ally of this aberrant genus, and to the justice of

[1] "Fossil Remains from Lake Callabonna." Part II. (1) Genyornis Newtoni. (2) The Physical Features of Lake Callabonna. By E. C. Stirling, F.R.S., and A. H. C. Zeitz, C.M.M.Z.S. (Mem. Royal Soc S. Austr., vol. i. Part 2, pp. 41–80 and i.–xv., 6 photographic plates, 1900.)

their decision their photograph of the sternum, which is typically Dromæan, alone gives ample support.

Other remarkable features are the slenderness of the tarso-metatarsus and lower portion of the tibio-tarsus, and the general feebleness of the digits, the ungual phalanges of which are small, and believed to have borne "flattened nails rather than sharp and powerful claws, which could have been of little service for scratching purposes," the whole pedal skeleton, in fact, being in striking contrast with the massive proportions of the upper-leg bones and sternum. There is a moderate fibula well preserved.

Two small fragments of the coraco-scapula and some three or four ribs are described. Of the carpus there is no trace, and doubt besets a small bone referred to as a possible phalanx of the fore-limb. Concerning the anti-brachium, however, the radius and a possible ulna are preserved; and for the former the authors give measurements which show that, in contradistinction to that of all other Ratitæ, it far exceeds the humerus in length—a feature in respect to which the Emeu comes most nearly approximate but is still a long way behind.

Of remains in good preservation, or that, by the ingenious method of preparation adopted, upon which we have already commented (NATURE, vol. lxi. p. 276), could be rendered serviceable, those of the tibio-tarsalia were by far the most numerous; and in the present memoir the authors devote special attention to chemical action brought to bear upon those bones found nearest the surface, to which is due their friability and peculiar texture, associated with the formation of crystals, mostly of halite, admixed with gypsum, glauberite and alunite, by which they had become impregnated. The Memoir gives promise of further interesting results, and any one at home desirous of examining the remains will now find in the Geological Department of our National Museum at South Kensington a fine example of a hind-limb, in which the extraordinary diversity in bulk of the opposite ends of the tibio-tarsus, and the still more noteworthy slenderness of the innermost digit, must be seen to be appreciated.

SOME EXPERIMENTS ON THE DIRECT-CURRENT ARC.

ON Thursday last, December 13, Mr. W. Duddell read before the Institution of Electrical Engineers a paper on "Rapid Variations in the Current through the Direct-Current Arc," which he illustrated by experiments. Members of the Institution have already learnt from the experimental demonstration given by Mr. Duddell in 1898, when he read the paper by Dr. Marchant and himself on the alternate current arc, to expect from him most interesting experiments. Nor were they disappointed last Thursday. It is perhaps too much to say that the experiments then shown excelled in beauty and interest those exhibited on the former occasion, but they fully maintained the same high level of excellence.

Mr. Duddell has been carrying out experimental research on the arc for the past five or six years, and during the last two has, we understand, completed a series of experiments on the vexed question of the resistance of the arc. The questions dealt with in the paper read last Thursday were mainly side issues which had cropped up in the course of these researches. They embody, however, a number of most interesting and important results, many of which are suggestive of great possibilities.

The paper was divided into two parts, the first dealing with those cases in which the cause of the variation of the current was in the circuit outside the arc, the second with the cases where the cause was in the arc itself. Under the first heading, Mr. Duddell gave the results of experiments which he had made on the rapidity with which the P.D. between the electrodes of the arc, and the light emitted by the arc itself and the crater on the positive carbon, can follow variations of the current. The results show that the rapidity is surprisingly great. It is well known that with ordinary slow variations of the current through an arc a rise in current is accompanied by a fall in P.D. If the conditions of the arc were to remain unchanged, the P.D. would rise with a rise of current; but Mr. Duddell has found that the conditions of the arc can change as rapidly as 5000 times a second or more, and that when the current through an arc between *solid* carbons is suddenly increased it is only for the first 1/5000th of a second that the P.D. rises with the current. Messrs. Frith and Rodgers endeavoured, in 1896, to find the resistance of the arc by superimposing on a direct-current arc an alternating current having a frequency of 250 alternations per second, and measuring the change in P.D. thereby produced on the assumption that at this frequency the conditions of the arc did not change. The results of Mr. Duddell's work show that a frequency of at least 5000 alternations per second must be employed before such an assumption is justified.

It is remarkable also to find that the light emitted by the arc is affected by such small and rapid variations as Mr. Duddell found was the case. The light emitted by the crater and the vapour column varies sufficiently distinctly for a photographic record to be obtained even when the frequency of the superimposed variations in current is as high as 4300 alternations per second, and the amplitude of the variation as low as 3 per cent. of the mean.

When the current through the arc is altered, a change in the cross section of the vapour column is caused; and these changes, when the variations are rapid and periodic, give rise to audible sounds. Mr. Duddell has found that a variation of the order of one part in 10,000 from the mean current will alter the vapour column sufficiently to produce sound-waves. In this way an arc may be made to act as a telephone receiver by causing the varying currents in a telephone circuit to pass through the arc. An experiment was shown at the meeting in which the arc in the meeting room was used as a receiver for telephone currents from a transmitter spoken into in the basement of the building. The sounds were distinctly audible throughout the room, though the words could hardly be distinguished beyond a distance of some 10 or 12 feet. These results were obtained with a cored carbon arc—some 20-30 mm. in length and with a current of about 10 ampères.

The second part of the paper, dealing with changes of current produced by the arc, was full of interest and importance, and was illustrated by some very striking experiments. Mr. Duddell first described some experiments on the humming arc, in which he had found, by means of curves obtained with his oscillograph, that the P.D., current, and light emitted by the arc varied with the same frequency, this frequency being identical with the pitch of the note emitted. With the hissing arc Mr. Duddell finds a double variation—a large slow one, which is due, he considers, to the rotation of the arc as a whole, on which is superimposed a small rapid variation in the P.D. and current corresponding with the variation of the light emitted by the crater, this variation being produced, as Mrs. Ayrton has shown, by air obtaining access to the surface of the crater.

Perhaps the most remarkable points brought out by Mr. Duddell in his paper were those relating to the effects produced by shunting the arc with a condenser and self-induction. He has shown that the arc, if it be formed between *solid* carbons, when so shunted immediately becomes intermittent and emits a musical note. Mr. Duddell was led to this discovery by attempting to use the arc as a generator of alternating current by

rendering it intermittent by blowing it with a magnet. This method did not answer, as the intermittence was too irregular; and in order to try and overcome this irregularity Mr. Duddell shunted the arc with a condenser, and found that the arc immediately became intermittent without any blowing, and emitted a musical note. It appeared that the leads from the arc to the condenser possessed appreciable self-induction, and that if this were destroyed the musical note ceased. It thus became evident that a direct current arc between *solid* carbons, when shunted by a capacity in series with self-induction, supplied alternating current to the shunt circuit—the complete circuit consisting of the arc, self-induction, and capacity in series, the arc thus acting as a converter of direct into alternating current energy.

This effect can only be produced when the arc has the ratio of a small change in P.D. (∂V) to the corresponding change in current (∂A) *negative;* and when this ratio $\partial V/\partial A$ is numerically greater than r, the resistance of the condenser circuit. This was proved by Mr. Duddell with two experiments. With a cored carbon arc for which $\partial V/\partial A$ is positive he showed it was impossible to obtain a musical note. And using a solid carbon arc shunted by a condenser and self-induction and giving out a clear note, he showed that by increasing the resistance of the condenser circuit the sound steadily diminished and finally completely died out when this resistance became numerically equal to $\partial V/\partial A$. Any cause tending to dissipate the energy in the condenser circuit, such as, for example, the hysteresis of an iron wire core introduced into the self-induction, or any complete circuit, such as a sheet of iron or a closed ring of wire, brought near it, will also stop the note. This phenomenon suggests, as was experimentally demonstrated, a very simple and valuable method of obtaining oscillating currents of any desired frequency for experiments on magnetic space telegraphy.

Some experiments with metal arcs brought out two points of great practical importance. Mr. Duddell found that on shunting an arc between metal electrodes by a condenser the arc went out. The high rise of P.D. caused by thus suddenly breaking an inductive arc circuit may be sufficiently great to break down the insulation of the leads, as was shown by an experiment, in which a weak place in the insulation was introduced by bringing the two conductors to brass plates separated by a sheet of paper: every time the arc was shunted and put out, the paper was pierced by a spark. The same result was obtained by connecting the condenser permanently across the arc terminals and trying to strike the arc. This has important bearing on the practical use of metal switches, since it shows that the arcing at breaking should be encouraged rather than suppressed, since if there be capacity as a shunt to the switch-contacts and self-induction in the main circuit, a high rise in P.D. will occur, and may cause serious damage to the leads. As another instance of the practical application of this effect, Mr. Duddell showed that, when using an induction coil, a far longer spark could be obtained if the connections were made so that the contact maker first broke the circuit and then shunted a condenser across the gap to blow out the spark, instead of, as has always hitherto been done, having the gap permanently shunted by a condenser.

Mr. Duddell concluded his paper by showing that the note emitted by a musical arc could be tuned by adjusting the self-induction and capacity in the shunt circuit. A keyboard was arranged which shunted different capacities and self-inductions across the arc, and by this means two complete octaves were obtainable. Four arcs were arranged in series to increase the loudness of the sound, and a very distinct and not unmusical rendering of "God Save the Queen" was played on them.

The Central Technical College may well be congratulated on the work on the arc that has been done in its laboratories. Within the last two years there have been four most important papers on this subject read before the Institution of Electrical Engineers—Messrs. Duddell and Marchant's paper on the Alternate-current Arc, Mrs. Ayrton's paper on "Hissing Arcs," her paper at the Paris Congress on the "Light given out by the Direct Current Arc," and the paper by Mr. Duddell above described—all emanating from the College, and each contributing in no small degree to the elucidation of the many very difficult problems which the arc presents.

A BIRD-BOOK FOR YOUNG PEOPLE.[1]

WHETHER designedly or no, this attractive little volume is fortunate in the time of its appearance, since it forms an appropriate Christmas gift to young persons of both sexes interested in observing the ways of the birds of their own neighbourhood. And it is not even necessary that such young people should be resident in the country to appreciate the book, for the author, as in his account of the gulls on the Thames in winter, shows that there is much to be learnt with regard to bird-life even by the dweller in the metropolis. The appearance of a bird-book of this nature at the Christmas season is also appropriate in that it tends to draw attention to the severe hardships our feathered friends have frequently to suffer at this time of year, and thus attracts sympathy and attention to their wants.

To those of our readers who are familiar with the Messrs. Kearton by their previous works, no recommendation will be necessary in the case of the volume before us; while to those who have yet to become acquainted with the earlier literary and artistic efforts of these gentlemen, their new production will come as a welcome surprise. For although primarily intended for young people, it must not for a moment be supposed that the author's latest volume is not calculated to interest readers of more mature years. Indeed, the beauty and attractive character of the illustrations (two of which, by the courtesy of the publishers, we are enabled to reproduce) are alone quite sufficient to render the volume acceptable to readers of all classes and all ages. Mr. C. Kearton seems, indeed, almost to have surpassed himself, not only in the execution of the photographs, but in the interesting phases of bird-life and bird-architecture he has portrayed. All the photographs, it appears, have been specially taken for this particular volume, and as they reach one hundred in number, while their *venue* extends from the Thames Embankment to the Hebrides, some idea may be gathered of the amount of time, labour and money expended in its production.

A feature of the book is the attention devoted to nests, eggs and young birds; and although the style is essentially popular and suited to the capacity of the readers for whom it is primarily intended, older ornithologists will scarcely fail to be interested in the chapters on these subjects. In particular we may draw attention to the eight photographs on p. 99, the first of which represents a blackbird's egg on the day previous to hatching, and the other seven the young bird from day to day. By a careful arrangement and adjustment of the camera, the young bird was photographed to the same scale, and the marvellous rapidity of its development—especially between the fourth and seventh day of its existence—will come almost as a revelation to many readers. Unfortunately the further progress of the daily portraiture was brought to an abrupt termination by the unwelcome attentions of a cat. The subject is, however, full of promise, and one worthy to be taken up by other photographers.

1 "Our Bird Friends: a Book for all Boys and Girls." By R. Kearton. With photographic illustrations by C. Kearton. Pp. xvi + 215. Illustrated. (London: Cassell and Co., Ltd., 1900.)

The precautions adopted for concealing their eggs while birds are temporarily absent from the nest claim a considerable share of the author's attention; particular interest attaching to the description and illustration of the manner in which moorhens are in the habit of bending down some of the adjacent reeds in order to prevent the eggs from being seen from above. Not less attractive are the illustrations showing the contrast in the appearance of the nest of the eider-duck when just vacated by the parent bird and when the eggs are enveloped in a mantle of fleecy down. Other illustrations display the adaptation of the eggs of the plover tribe to their environment, as well as the economy in space obtained by the clutch of four being placed with their narrow ends pointing inwards, both these features being admirably displayed in the annexed photograph of a ringed plover's nest. While on the subject of eggs it may be mentioned that some confusion is, we think, likely to occur in identifying which is the raven's and which the curlew's egg in the photograph on p. 80. And it may be added that, on the same page, *Epyornis* is not the way to spell the scientific name of the extinct Malagasy roc, which is compounded from the Greek αἶπυς.

FIG. 1.—Eggs of the Ringed Plover. (From Mr. Kearton's "Our Bird Friends.")

Another subject to which the author directs the attention of his readers is the connection between the structure and form of feathers and the uses they are intended to subserve; and here, again, the illustrations admirably assist in the interpretation of the letterpress. After describing the manner in which a gannet dashes into the water in its headlong descent when in pursuit of prey, Mr. Kearton proceeds to observe that "the shock produced by such a heavy bird suddenly striking the surface of the ocean after descending from a considerable height at great velocity would kill some species of smaller size on the spot. But the gannet has been properly equipped for its task. The shafts and vanes of its breast feathers have been tremendously thickened, and their quills are buried in a quarter-inch-thick pad of very close-set down, which acts like a buffer when its wearer strikes the surface of the sea."

Contrasted with this are the "fluffy" and loosely-attached feathers on the breast of the heron, which fishes while standing, and therefore needs no breast-plate.

In his preface the author tells his young readers how, when a child, he was delighted by bird-stories told by his grandfather. "They," he adds, "will enjoy a great advantage over me in being able, through the achievements of my brother's camera, to examine accurate pictures of the birds living, loving and labouring amidst their natural surroundings." No words of ours can add aught to this modest description of the most attractive feature of a charming book.

R. L.

HUXLEY MEMORIAL.

WE have received a copy of the final report of the Huxley Memorial Committee, which announces the completion of their task, and is accompanied by a full donation list, signed on behalf of the committee by the Hon. Treasurer and Secretary. It shows the cost of the statue to have been 1814*l.*; of the dies for the medal 264*l.*, inclusive of all that pertained to each; and this, with the sum of 201*l.* for total working expenses, and the balance of 1126*l.*, paid to the Board of Education as an endowment for the medal at the Royal College of Science, brings the total amount received and expended to a little over 3450*l.*, as compared with the Owen Memorial, which realised 1100*l.*, the Darwin rather more than 5000*l.*, and the Jowett about 10,000*l.*

The statue we have already described (NATURE, vol. lxii. p. 12), and of the medal for the Royal College of Science and the arrangement for the production of a memorial medal at the Anthropological Institute, to which we alluded at the same time, the report contains nothing that is new. It concludes with the thanks of the committee to the Hon. J. Collier for the gift of a portrait of the late Prof. Huxley to the National Portrait Gallery, in lieu of their inability to provide one.

The number of persons of distinction of all nationalities who ultimately consented to join the "General Committee" was close upon 750, and of these one-third were foreigners, 33 colonials. All but 60 of them subscribed; and the total number of contributors was

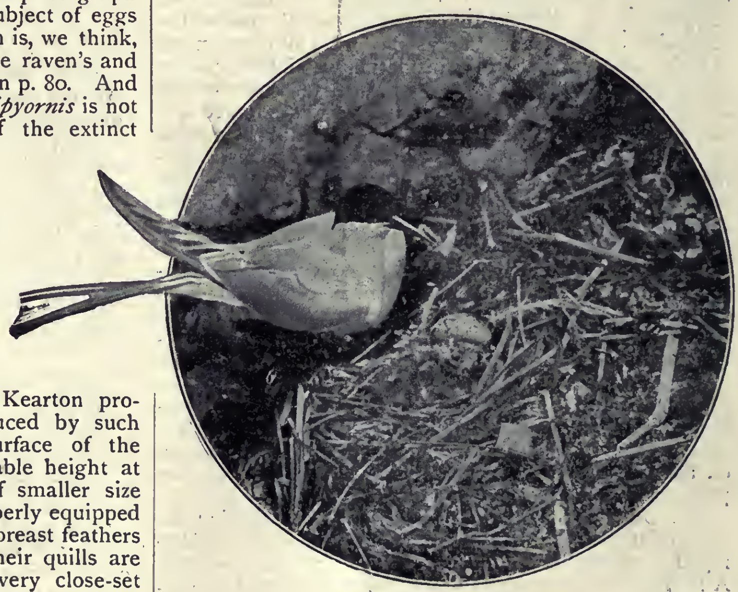


FIG. 2.—Arctic Tern guarding her nest. (From Mr. Kearton's "Our Bird Friends."

901, exclusive of local committees, societies, institutions and field clubs, each of which embraced a number of donors, and of which there were 22, making in all a total of 923 entries on the list, and of over 1000 individual subscribers. The sum raised by local subscription was 351*l.* Leeds heads the list with 54*l.*, Calcutta follows with 51*l.*, the New York Academy with 50*l.*, New Zealand contributes 30*l.*, Leicester 25*l.*, South Australia 21*l.*; and these, with Boston, U.S.A., Bristol, Cheltenham, Chester, Chicago, Chili, Ealing, Nebraska, New South Wales, New York, Paris, Servia, St. Petersburg, Upsala, Warrington, and Washington, embrace the chief colonies and centres in this way represented, together with the National Sunday League and the students of the Royal College of Science. The list includes the names of individuals resident in extreme latitudes and on the opposite sides of the globe, the sums contributed ranging from 100*l.* to half-a-crown.

The Executive Committee (of which we published a list in NATURE, vol. liii. p. 186) held twelve meetings, under the chairmanship of Lord Shand, and duly appointed sub-committees of their number for the carrying out of details. Of the subscribers, 48 died during the interval of payment and publication of the list, and of the executive, two—viz., Sir E. Frankland and Sir W. Flower, passed away before the completion of their task. Four members did not attend a meeting at all.

Concerning the statue, it may be placed on record that the late Prof. Max Müller early expressed in writing the desire that Huxley and Tyndall should be memorialised together, as are Goethe and Schiller at Weimar.

The medal, which we have not before described, bears on the obverse a profile portrait, with name in full and dates of birth and death; on the reverse a female figure with a lighted lamp in the left hand, and a laurel wreath in right, which she is about to deposit on an altar bearing the word ΕΠΙΣΤΗΜΗ, the whole backed by the foreshortened façade of the Royal College of Science. The designs for the medal were obtained by prize competition, and of the sixty-two persons who applied thirty-four competed. The premiated designs were twice the diameter of the dies (viz. 5 inches), and silver replicas of them, presented to the Royal College of Science, hang in Huxley's work-room, now a research laboratory bearing his name, beneath his portrait by Legros, and surrounded by personal relics and his working scientific library and effects, in themselves second to no memorial to his labours.

Specimen copies of the medal have been presented to Mrs. Huxley, to the British and South Kensington Museums, and, conjointly with an enlarged copy of the obverse, to the Royal Society, for their respective collections. By purchase at the cost of production, there have been acquired two sets of impressions by continental museums, and copies of the obverse in various sizes, to the number of thirty-six, by subscribers to the fund in many parts of the world.

Among the proposals for the once contemplated third object of memorial, of which the amount subscribed did not admit, there were submitted in writing suggestions for a Studentship (1) at the Royal College of Science; (2) at the Zoological Gardens, in recognition of Huxley's services to the Society, and of his connection with the foundation of its Prosectorship; for (3) a Scholarship at one of the Universities, to be open to all boys of the United Kingdom, and under the control of the Royal College of Surgeons (with an offer of 50*l.* if acted upon); for a Professorship (4) of Anthropology, and (5) of Hygiene; and (6) for a silver medal to the size of the original design for award by the Royal Society.

NOTES.

THE following have been nominated presidents of sections for the Glasgow meeting of the British Association, September 11–18, 1901: A (Mathematical and Physical Science), Major P. A. MacMahon, F.R.S.; B (Chemistry), Prof. Percy Frankland, F.R.S.; C (Geology), Mr. John Horne, F.R.S.; D (Zoology), Prof. J. Cossar Ewart, F.R.S.; E (Geography), Dr. H. R. Mill; F (Statistics and Economic Science), Sir Robert Giffen, K.C.B., F.R.S.; G (Engineering), Mr. R. E. Crompton; H (Anthropology), Prof. D. J. Cunningham, F.R.S.; I (Physiology), Prof. J. G. McKendrick, F.R.S.; K (Botany), Prof. I. Bayley-Balfour, F.R.S.

IN accordance with a resolution which was passed by the General Committee of the British Association at the annual meeting held last September at Bradford, the Council of the Association have recently considered the advisability of establishing a separate section for education. We are informed that the Council have decided that a section of educational science shall be established, but that the section shall not necessarily meet each year. The first meeting of the section will be held at the Glasgow meeting, which will commence on September 11, 1901.

FOR the purposes of a National Physical Laboratory, the Queen has granted to the Royal Society Bushey House, Bushey Park, which was formerly occupied by the Duc de Nemours.

THE Linnean Society has undertaken the collection of title-slips for the United Kingdom of Great Britain and Ireland as regards botany for the International Catalogue of Scientific Literature. All botanists are asked to support the endeavour to compile a complete record. Societies and other publishing bodies are requested to help by sending their issues as soon as possible after publication, either by gift, loan or exchange, so as to co-operate in producing a yearly record of botanic literature throughout the world. Communications for the catalogue should be addressed to Mr. B. Daydon Jackson, Linnean Society, Burlington House, London, W. Other scientific societies will, we presume, render similar assistance to the work of the International Council.

A FEW weeks ago the new anthropological collections in the American Museum of Natural History in New York were opened to the public, and these valuable collections now occupy five halls, and others are being provided. We learn from our contemporary, *Science*, that the accessions to the anthropological collections of the museum obtained during the last three years have largely been due to extended scientific research undertaken by the institution. In this respect the methods of the American Museum of Natural History differ considerably from those pursued by a number of other institutions. It has not been the policy of the museum to accumulate rapidly and indiscriminately more or less valuable specimens collected on trading expeditions or purchased from dealers; but an endeavour has been made to build up representative collections and to obtain, at the same time, the fullest and most detailed information in regard to specimens, so that each addition to the exhibit of the museum can be made thoroughly instructive and will represent a material contribution to science. There is no doubt this is the best way to build up a museum, and it is to be deplored that the various museums of the British Islands do not follow the example so worthily set by this and other American museums. Our English method is rather to wait like a spider in its web in the hope that something will eventually be caught; in the meanwhile, other institutions are intelligently collecting wholesale in diverse interesting regions, while we are content with occasional specimens which usually have no history, or at most a very imperfect one, and for these we often have to pay a stiff profit to a dealer.

King Oscar of Sweden and Norway has given a sum of 0,000kr. towards the archæological researches of Dr. L. Kjellberg in Asia Minor and the island of Lesbos.

Dr. E. von Drygalski, leader of the German Antarctic Expedition, has been elected an honorary corresponding member of the Royal Geographical Society.

Prof. Arthur Thomson, professor of human anatomy in the University of Oxford, has been elected professor of anatomy in the Royal Academy.

M. Painlevé has been elected a member of the section of geometry of the Paris Academy of Sciences in succession to M. Darboux, who has been appointed permanent secretary for the sections of mathematical sciences.

A School of Forestry has been established in connection with Yale University, under the direction of Prof. Toumey. Its home will be the residence and grounds of the late Prof. Marsh, which he bequeathed to the University for a botanical garden.

The Botanical Department of the British Museum has recently acquired M. Bescherelle's herbarium of exotic Musci and Hepaticæ, consisting of 14,800 specimens of the former and 3500 of the latter family. It contains a very large number of type-specimens.

Prof. B. D. Halsted has been elected president of the Botanical Society of America for the coming year. The *Botanical Gazette* states that an important step has been taken by the Society in appointing a committee to consider the best means of realising the purposes of the Society in the advancement of botanical knowledge. Among other matters the committee will consider the uses to which the accumulating funds of the Society may be put.

A kinswoman of Faraday has made over to the Browning Settlement a ten-roomed house at East Dulwich, to be used as a home of rest and change for the poor, and to be called the Michael Faraday Home. To fit the Home for permanent use, the sum of 150*l.* will have to be spent on alterations and repairs. The annual cost of maintenance and hospitality will be at least 100*l.* To meet this outlay an appeal has been made for funds, and it is hoped that men of science will give their support to an object which would have had the sympathy of Faraday, and which will stand as a memorial to him in his native parish. Subscriptions should be forwarded to the Warden, Robert Browning Settlement, Walworth, London, S.E.

We see in the *Athenaeum* the announcement of the death of Dr. William King. In 1857, after graduating at Galway, Dr. King went to Calcutta to join the Geological Survey Department of India, where he spent thirty-seven years, during the latter six of which period he was Director of the Geological Survey Department of India, having succeeded Dr. Medlicott. During the seven years of his directorship considerable progress was made by the Survey in the prospecting and development of the coal, oil and tin areas of the Punjab, the North-West Provinces and Burma, and in the elucidation of the complicated geological structure of the North-West Himalayan salt range and the Baluchistan formations.

A Danish expedition, composed of Lieutenant La Corn, leader, MM. Middilbo and Kofoed, physicists, and the artist Count Harald Moltke, left Copenhagen recently for Finland *via* Christiania, Trondhjem and Vadso with the object of studying the Aurora Borealis. The chief station will be established at Utsjoki, in North Finland, where the expedition will remain three months. Spectrum and magnetic researches will also be carried out. The expedition is the second of its kind dispatched under the auspices of Dr. Adam Paulsen, director of the Copenhagen Meteorological Institute.

Sir John Conroy, Bart., F.R.S., whose death at Rome occurred on December 15, will be missed in the University and city of Oxford. He was educated at Eton and Christ Church, and obtained a First Class in Natural Science in 1868. When he was elected a Fellow of the Royal Society in 1891, he was lecturer in physics and chemistry in Keble College, and an assiduous student of experimental science. Among the subjects of his contributions to science are the dioxides of calcium and strontium, the polarisation of light by crystals of iodine, the light reflected by potassium permanganate, the distribution of heat in the visible spectrum, and experiments on metallic reflection.

News has just reached us that Prof. John Gardiner, who directed the department of biology in the University of Colorado at Boulder, Colorado, from 1889 to 1898, died from consumption on November 26. Prof. Gardiner was thirty-eight years of age and a graduate of the University of London, and in 1887 he occupied the British Association's table at the Naples Biological Station. He was an enthusiastic student of biology, a man of rare culture in other lines, a fine lecturer, and was prevented from original work only by bodily weakness and the necessities of the large department over which he presided.

When observations are being made by members of the Antarctic expeditions next year, it is important that as many similar and simultaneous observations shall be recorded in North Polar regions. Several Arctic expeditions will probably be in the field, and the leader of one of them, Mr. E. B. Baldwin, who has recently arrived in England, is making arrangements to carry on as much scientific work as is practicable for a private expedition. In an interview with Reuter's representative he stated that as Lieut. Peary and Captain Sverdrup are both in Greenland, his Polar route will probably be by way of Franz Josef Land. The expedition will number at least twenty to twenty-five men, mostly Americans. Two ships will be employed in the expedition, one to return home after the Arctic regions have been entered, and the other to proceed as far north as possible. Both will start at practically the same time. These vessels will be of the whaler type, such as are usually employed in Arctic work. The exact date and point of departure of the expedition will depend upon the developments of the coming spring with regard to Peary and Sverdrup.

Replying to questions asked by Mr. Seton-Karr in the House of Commons on Thursday last, Viscount Cranborne said that regulations for the preservation of wild animals have been in force for some time in the several African Protectorates administered by the Foreign Office as well as in the Sudan. The obligations imposed by the recent London Convention upon the signatory Powers will not become operative until after the exchange of ratifications, which has not yet taken place. In anticipation, however, steps have been taken to revise the existing regulations in the British Protectorates so as to bring them into strict harmony with the terms of the convention. The game reserves now existing in the several Protectorates are :—In (*a*) British Central Africa, the elephant marsh reserve and the Shirwa reserve ; in (*b*) the East Africa Protectorate, the Kenia District ; in (*c*) Uganda, the Sugota game reserve in the north-east of the Protectorate ; in (*d*) Somaliland, a large district defined by an elaborate boundary line described in the regulations. The regulations have the force of law in the Protectorates, and offenders are dealt with in the Protectorate Courts. It is in contemplation to charge special officers of the Administrations with the duty of watching over the proper observance of the regulations. Under the East African game regulations only the officers permanently stationed at or near the Kenia reserve may be specially authorised to kill game in the reserve.

DR. BENJAFIELD, a medical man who has resided for the last twenty-seven years in Tasmania, described the advantages of the Colony as a health resort, at the Imperial Institute on Monday. He said that he was struck, on his arrival in Tasmania, with the almost complete absence of consumption and bronchitis, and it was now three years since he had signed a certificate of death from the former disease. Last year the rural mortality of Southern Tasmania was only 8·8 per 1000. In Hobart 2261 hours of sunshine have been recorded in one year, as against 1158 at Oxford in England. The climate of the Colony is one of the most even and excellent in the world. The atmosphere is pure, clear and crisp, and the general prevalence in the air, as indicated by the characteristic odour, of the essential oil of the eucalyptus tree, existing in abundance in the Colony, especially near Hobart, appears to exercise a direct antiseptic influence against deleterious organisms of all kinds.

WE have received from the *Deutsche Seewarte*, Hamburg, the ninth volume of meteorological observations made at stations beyond the sea. The observations are taken three times daily with duly verified instruments, and form a very valuable contribution to the climatology of various distant parts of the globe. Some of the stations in Labrador have been in regular operation since the time of the international polar expeditions in 1882–3, and are the more important as they lie in the track of the barometric depressions which pass from the Canadian shores into the Atlantic. Wherever the German nation gets a footing abroad, scientific investigations, and especially meteorological observations, are undertaken; in addition to the stations in Labrador, the present volume contains observations at Tsing-chow, Apia, Nauru (Pleasant Island), Ralum (New Pomerania), Mogador, and several stations on the west coasts of Africa. Observations are also being made in the German East African Protectorate, and will, it is hoped, be published in the next parts of this useful work.

THE November issue (vol. vi., No. 2) of the *Journal* of the Marine Biological Association of the United Kingdom contains an extremely interesting and important report on the fauna of the Salcombe Estuary, which has been drawn up by Messrs. E. J. Allen and R. A. Todd, with the assistance of several specialists. Salcombe Harbour possesses an exceptional zoological interest in that it was the hunting-ground of George Montagu in the earlier years of the century, and is consequently the type locality for a considerable number of British marine animals. Partly for this reason and partly because previous visits had demonstrated the richness of its fauna, the harbour was selected as a promising field for a systematic zoological survey, which was undertaken during the past summer. The authors state that the present report, from which the "plankton" is excluded, "consists almost entirely of a record of facts with regard to the nature and distribution of the fauna as we have found it during the present summer, consideration and discussion of these facts and comparison with the conditions prevailing in other localities being held over until further investigations on a similar plan have been carried out elsewhere." It does not appear that any new species were obtained.

BOTH to fishermen and to naturalists the article by Mr. W. Garstang, dealing with the plague of octopus on the South Coast and its effects on the crab and lobster fisheries, which appears in the *Journal* of the Marine Biological Association, will appeal strongly. Till the spring of 1899 the common octopus has been comparatively rare in the Plymouth neighbourhood for the last decade or so, as much as half-a-sovereign having been paid for a specimen. At that epoch, however, a marked increase in the numbers of this voracious mollusc was noticed, and during the year just closing it has appeared in such hosts as to cause widespread disaster to the shell-fish industry on both sides of the channel. Several newspaper paragraphs are quoted in evidence of the serious nature of the plague, which the author is inclined to believe is in part due to the exceptional heat of recent summers.

THE Italian earthquakes have formed the subject of a memoir by Perrey and of several detailed studies by Prof. G. Mercalli. Very numerous notices are also to be found in scientific journals, in literary and historical works, in newspapers and in books now become rare. The materials from these various sources are collected and discussed in a valuable work by Dr. M. Baratta, recently published. It consists of three parts. The first is a catalogue of 1364 of the more important earthquakes from the beginning of the Christian era to the end of 1898. In the second the seismic history of different districts is investigated, while the third contains a bibliography of more than 1600 papers, &c., on Italian earthquakes. The first two parts are illustrated by 136 seismic maps.

IN *Die Umschau*, Herr A. Stolberg gives an account of the last ascents of Count von Zeppelin's navigable balloon. The paper is illustrated by diagrams showing the modifications introduced into the construction of the machine since the earlier ascents, from which it appears that the suspended platform supporting the sliding weight used in maintaining longitudinal balance has been replaced by a latticed girder arrangement from which the weight is suspended, and, moreover, the steering arrangements have been considerably altered. The author estimates the speed of propulsion relative to the air at about 8 metres per second; and the total weight of the machine at about 10,200 kilogrammes, say ten tons.

THE latest invention in connection with wireless telegraphy is an apparatus designed to warn ships of their approach to a danger in times of fog or places where a simpler system of signalling is not practicable. The contrivance consists of a revolving wheel, having teeth of varying size, which, as it revolves, operate a Morse key connected with wireless telegraphy transmitting instruments, and according to the length of time they keep it depressed cause long or short signals to be transmitted. These signals represent the dashes and dots of the Morse code, and hence it is easy to dispose the teeth of the wheel so that any place sends out signals which spell its name. The wheel, which may be rotated by an electric motor or by clockwork, can be arranged to signal every minute or two or continuously, as desired, the idea being that it should be put into operation whenever bad weather comes on. In this way any place can be made the centre of a zone of influence, practically of any required extent, so that all ships coming within it will be notified of the fact by the ringing of an electric bell and the reception of a message giving the name of the place, provided they are fitted with apparatus for detecting the electric waves.

MR. GUSTAV FISCHER, Jena, has commenced the publication of the second revised and enlarged edition of Prof. A. Lang's "Lehrbuch der vergleichenden Anatomie der wirbellosen Thiere." The new edition will be in three volumes, the first containing four parts, the second three parts, and the third two. The part just issued is the first of the third volume, and in it Dr. K. Hescheler deals with the mollusca.

"Appendix No. 1," for 1901, of the Kew *Bulletin of Miscellaneous Information* consists of a list of the seeds of hardy herbaceous annual and perennial plants and of hardy trees and shrubs which, for the most part, have ripened at Kew during the year 1900. These seeds are not sold to the general public, but are available for exchange with colonial, Indian and foreign botanic gardens, as well as with foreign correspondents of Kew. No application for a share in their distribution, except from remote colonial possessions, will be entertained after the end of March.

IN the September number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, N. S. Kournakow gives an account of his investigations on the alloys formed by sodium and potassium with mercury and of sodium with cadmium, lead and bismuth. The method employed was the determination of the temperature of fusion. Curves are drawn representing the variation of the temperature of fusion with the composition, and in all cases these curves are characterised by very distinct temperature maxima. In the case of the combination sodium and mercury, no less than seventy-five experiments have been carried out, each with a different proportion of the components. The maxima of temperature referred to are remarkably high—346° C. in the case of sodium and mercury, and 269·7° C. in the case of potassium and mercury, and the composition of the alloy corresponding to these temperatures is exactly represented by the formulæ $NaHg_2$ and KHg_2. The freezing-point depression curves which proceed from these temperature maxima are shown to extend through large temperature intervals. In the case of $NaHg_2$ the curve extends from 346° C. to 218° C. on addition of sodium, and to 155° C. on addition of mercury. The combinations of sodium with cadmium, lead and bismuth are also distinguished by very high temperature maxima, these being respectively 395°, 420° and 720° C., whereas the melting-points of the pure metals are Na 96°, Cd 322°, Pb 326°, and Bi 268° C. These characteristic temperatures correspond exactly with the formulæ $NaCd_2$, Na_2Pb, and Na_3Bi. The author draws attention to the similar phenomena which have been observed with the combinations—aluminium and gold, aluminium and antimony—and concludes that in these latter the aluminium functions as an alkali metal, giving rise to the same peculiarities as sodium and potassium in the alloys investigated by himself.

IN Prof. Cook Wilson's letter on the formula of inverse probability (p. 154) the following corrections should be made, though they do no not affect the fundamental argument: In line four of letter, for C_r and P_r read C_n and P_n; in line six, for p_r read p_n; p. 155, col. 2, line 13, for "in reality" read "on reality"; in penultimate paragraph, the last word, "strong," should be "strongest"; and in the eighth line from end, "the head" should read "this head." Finally, Prof. Wilson wishes $\frac{p_r P_r x}{\Sigma p P}$ (line 19, col. 1, p. 155) to read $\frac{p_r P_r x}{\Sigma p P x} = \frac{p_r P_r}{\Sigma p P}$.

FROM Mr. W. Engelmann, Leipzig (London: Williams and Norgate), the following scientific works have been received:—The third edition of A. de Bary's "Vorlesungen über Bakterien," revised and partly rewritten by Prof. W. Migula; Part i. of "Studien über die Verbreitungsmittel der Pflanzen," by Dr. M. Kronfeld, dealing with fertilisation effected by wind; and two parts of "Das Pflanzenreich," a conspectus of the vegetable kingdom, edited by Prof. A. Engler under the auspices of the Prussian Imperial Academy of Sciences. The plants described in these parts belong to the Musaceæ, Typhaceæ and Sparganiaceæ.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, presented by Captain W. G. Ambrose; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mr. W. J. Langton; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Miss L. Harold; a Stair's Monkey (*Cercopithecus stairsi*, ♂) from the Lower Zambesi, presented by Miss J. C. S. Purves; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Miss M. A. Reeve; a Duke of Bedford's Deer (*Cervus xanthopygius*, ♀) from Manchuria, presented by H.G. the Duke of Bedford; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Captain F. E. Cannot, A.S.C.; a Spur-winged Goose (*Plectropterus gambensis*) from West Africa, presented by H.E. Colonel F. Cardew, C.M.G.; a Common Heron (*Ardea cinerea*), two Mediterranean Peregrine Falcons (*Falco punicus*) from Mogador, presented by Mr. W. T. Barneby; a Kinkajou (*Cercoleptes caudivolvulus*) from South America, a Blue-bonnet Parrakeet (*Psephotus haematorhous*) from Australia, an Eupatorian Parrakeet (*Palaeornis eupatria*) from India, a Patagonian Conure (*Cyanolyseus patagonus*) from La Plata, three Caspian Terrapins (*Clemmys caspica*) from Western Asia, deposited; two Black-tailed Parrakeets (*Polytelis melanura*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

NEW VARIABLE IN CYGNUS.—Mr. A. Stanley Williams announces in the *Astronomische Nachrichten*, Bd. 154, No. 3675, the detection of a new variable star. Its position is

$$\left.\begin{array}{l}\text{R.A.} = \text{20h. 59m. 50s.} \\ \text{Decl.} = +28^\circ\ 49'\cdot 6\end{array}\right\}(1855\cdot 0).$$

The magnitudes were obtained from measurements of photographs obtained with a Grubb 4·4 inch portrait lens, and were as follows:—

1899.	Oct.	6	...	Mag. = 9·85
		9	...	= 9·85
1900.		26	...	= 11·0
	Nov.	15	...	= 11·4
		22 (hazy)		= 11·4±.

In the same journal Prof. Kreutz gives a list bringing together all the new variables discovered during the past year.

SPANISH OBSERVATIONS OF THE ECLIPSE OF MAY 28.—A preliminary report of the observations of the total eclipse of the sun, May 28, made at Plasencia by the official party of Spanish astronomers, has just been issued by Señor Iniguez, director of the Madrid Observatory. The principal objects of the expedition were to record the times of the four contacts, to obtain photographs of the corona, and to determine the position of the green line of the coronal spectrum. The attendant phenomena, however, were not neglected. Among the larger instruments employed were an equatorial refractor of 20 centimetres aperture and 3 metres focus, a photographic equatorial of 20 centimetres aperture and 2 metres focus, a photographic telescope of 16 centimetres aperture and 1 metre focus, and a six prism visual spectroscope worked in conjunction with a cœlostat and horizontal telescope. The weather conditions were excellent, and a very graphic account of the general work of the expedition and of the eclipse itself is given. Five excellent photographs of the corona were obtained, three with the larger and two with the smaller coronagraph. It is remarked that the principal prominences were unconnected with the coronal extensions, and that in one of the photographs the streamers can be traced to a distance of about three diameters. For the green coronal line a wave-length of 5297·3 was determined, as compared with Sir Norman Lockyer's 5303·7 and Prof. Campbell's 5303·26 obtained from the photographs of 1898. Shadow bands were seen a minute and a half before totality, lying in a direction from south-west to north-east and travelling from north-west to south-east with a velocity comparable with that of a man walking, and at a distance apart of 8 centimetres. The atmosphere was so clear that the moon's disc was seen projected on the background of the corona for two minutes after the last contact. During the eclipse the thermometer in the shade fell 4° and that in the sun 8°. An interesting series of photographs is reproduced to show the reduction of light at various phases of the eclipse, and copies of the corona pictures are also included in the report. Señor Iniguez, to whom many foreign astronomers were indebted for much valuable information relating to their expeditions, is to be warmly congratulated on the admirable results of the efforts of his own party.

OPPOSITION OF EROS.—A sixth circular has been issued by M. Loewy from the Paris Observatory, containing ephemerides of 81 fundamental stars selected from the region including the trajectory of Eros during the period 1900 September–December,

intended for use in the reduction of meridian measures of the planet. The positions for 77 of these are given at intervals of 10 days, and for the remaining four polar stars daily positions.

Two other observatories have undertaken the special task of determining the co-ordinates of stars for reference—Charkow, directed by M. L. Struve, and d'Abbadia, directed by M. l'Abbé Verschaffel.

Many notices have come to hand indicating that a considerable number of successful determinations have been made, and a scheme is being considered to ensure the publication of all the combined results in such form as to be of the greatest service to the observers, and thus any one may be able to have access to the complete data.

M. de Campos Rodrigues, director of the Lisbon Observatory, writes saying that 743 observations have been made; heliometric measures have been commenced at Bamberg, by M. Hartwig; at the Observatory at Algiers 63 photographs have been taken.

Both at Paris and Algiers it has been found that an exposure of six minutes is sufficient to record stars as faint as 12·5 magnitude, and from special trials it is considered that with this exposure it is certain that a sufficient number of comparison stars will be obtained surrounding the planet. Prof. Hale has forwarded the times of observation at which Prof. Barnard has taken micrometer measures with the 40-inch Yerkes telescope, and a comparison shows that several of these, made during the first part of the night, correspond almost directly with others obtained at European observatories (Paris and Cambridge) during the second part of the night.

A letter from Prof. Comstock is also included, giving particulars for the accurate determination of the diurnal motion.

MARKING ON MARS.—A Circular received from the *Centralstelle* at Kiel announces a message from Prof. Pickering, who on December 8 received a telegram from Mr. Douglass, of the Lowell Observatory, Flagstaff, Arizona, stating that he had observed a projection on the northern edge of the Icarium Mare which remained visible for seventy minutes.

SPECTROSCOPIC INVESTIGATIONS OF GASES IN ATMOSPHERIC AIR.[1]

IN August last some tubes were filled at low pressure by an improved process with the more volatile gases of the atmosphere.[2] The air was liquefied directly from that above the roof of the Royal Institution by contact at atmospheric pressure with the walls of a vessel cooled below −200° C. When about 200 c.c. of liquid had condensed, communication with the outer air was closed by a stop-cock. Subsequently communication was opened, through another stop-cock, with a second vessel cooled by immersion in liquid hydrogen, and a part of the liquid from the first vessel, maintained at −210°, was allowed to distil into the second still colder vessel. When about 10 c.c. had condensed in the solid form in the second vessel, communication with the first vessel was cut off, and a manometer showed a pressure of gas of about 10 to 15 mm. of mercury.

This mixture of gases was passed into tubes previously exhausted by a mercury pump, but before reaching the tubes it had to pass through a U-tube immersed in liquid hydrogen so as to condense less volatile gases, such as argon, nitrogen, oxygen or carbonic oxide, which might be carried along by those more volatile. Previous trials with tubes filled in the same way, except that the U-tube in liquid hydrogen was omitted, showed that these tubes contained traces of nitrogen, argon and compounds of carbon. The tubes filled with gas which had passed through the U-tube showed on sparking no spectrum of any of these last-mentioned gases, but showed the spectra of hydrogen, helium and neon brilliantly, as well as a great many less brilliant rays of unknown origin. In addition, they showed at first the brightest rays of mercury, derived no doubt from the mercury pump by which they had been exhausted before the admission of the gases from the liquefied air. After some sparking the mercury rays disappeared, probably in consequence of absorption of the mercury by the electrodes, which were of aluminium.

In one experiment the mixture of gases in the second vessel, into which a fraction of the liquefied air was distilled as above described, was pumped out without being passed through the U-tube in liquid hydrogen and examined. This mixture was found to contain 43 per cent. of hydrogen, 6 per cent. of oxygen, and 51 per cent. of other gases—nitrogen, argon, neon, helium, &c.—and it was explosive when mixed with more oxygen. This shows conclusively that hydrogen in sensible proportion exists in the earth's atmosphere, and if the earth cannot retain hydrogen or originate it then there must be a continued accession of hydrogen to the atmosphere (from interplanetary space), and we can hardly resist the conclusion that a similar transfer of other gases also must take place. The tubes containing the residue of atmospheric gases uncondensed at the temperature of liquid hydrogen we have examined spectroscopically.

On passing electric discharges through them, without any condenser in the circuit, they glow with a bright orange light, not only in the capillary part, but also at the poles, and at the negative pole in particular. The spectroscope shows that this light consists in the visible part of the spectrum chiefly of a succession of strong rays in the red, orange, and yellow, attributed to hydrogen, helium and neon. Besides these, a vast number of rays, generally less brilliant, are distributed through the whole length of the visible spectrum. They are obscured in the spectrum of the capillary part of the tube by the greater strength of the second spectrum of hydrogen, but are easily seen in the spectrum of the negative pole, which does not include the second spectrum of hydrogen, or only faint traces of it. Putting a Leyden jar in the circuit, while it more or less completely obliterates the second spectrum of hydrogen, also has a similar effect on the greater part of these other rays of, as yet, unknown origin. The violet and ultra-violet part of the spectrum seems to rival in strength that of the red and yellow rays, if we may judge of it by the intensity of its impressions on photographic plates. We were surprised to find how vivid these impressions are up to a wave-length 314, notwithstanding the opacity of glass for rays in that part of the spectrum. The photographs were taken with a quartz calcite train, but the rays had to pass through the glass of the tube containing the gases.

We have made approximate measurements of the wave-lengths of all the rays which are sufficiently strong to be seen easily or photographed with an exposure of thirty minutes, and give a list of them below. These wave-lengths are computed to Rowland's scale, and were deduced from the deviations produced by two prisms of white flint glass for the visible, and of calcite for the invisible, rays. The wave-lengths assigned to the helium lines are those given by Runge and Paschen, and some of these lines were used as lines of reference. In general, the iron spark spectrum was the standard of reference.

The tubes when first examined showed the lines of the first spectrum of hydrogen vividly, and the earlier photographs of the spectrum of the negative pole contained not only the violet lines of hydrogen, but also the ultra-violet series as far up as λ 337. In order to get impressions of the faintest rays, exposures of half an hour or more were required, and a succession of photographs had to be taken so as to get different sections of the spectrum into the middle of the field, where measurement of the deviations would not be impeded by the double refraction of the calc spar. As the light of the negative pole only was required, the electric discharge was made continuously in one direction only, with the result that the hydrogen lines grew fainter in each successive photograph, and soon disappeared altogether. Along with the ultra-violet rays, the less refrangible rays of hydrogen also disappeared, so that no trace of the C or F line could be seen, nor yet of the second spectrum, so long as the current passed in the same direction as before. Reversal of the current soon made the F line show again, so that it seems that the whole of the hydrogen was driven by the current to the positive pole. The conditions under which this ultra-violet series shows itself are a matter of interest. It appears here in the midst of a brilliant spectrum due to gases other than hydrogen, and yet it is very difficult to obtain a photograph of it when no gas but hydrogen is known to be present, or, at least, to become luminous in the electric discharge.

We have had an opportunity of comparing the spectrum of the volatile residue of air with that of the more volatile part of gas from the Bath spring. The tube did not admit of the separate examination of the light from the negative pole, but

[1] "On the Spectrum of the more Volatile Gases of Atmospheric Air, which are not Condensed at the Temperature of Liquid Hydrogen." Preliminary notice by Prof. G. D. Liveing and Prof. Dewar.—Read before the Royal Society on December 13.

[2] In this paper we describe researches in continuation of those previously communicated to the Society by one of us, in a paper entitled "Application of Liquid Hydrogen to the Production of High Vacua, together with their spectroscopic Examination," *Roy. Soc. Proc.* vol. 64, p. 231.

was examined end on, so that the radiation probably included rays emitted from the neighbourhood of the negative pole. The whole of the hydrogen had been removed from the Bath gas, but not all the argon. In the spectrum of this gas the rays of helium are dominant, decidedly stronger than those of neon, although the latter are very bright. In the spectrum of the residue of atmospheric air the proportion of helium to neon seems reversed, for in this the yellow neon line is as much more brilliant than the yellow helium line as the latter is the more brilliant in the spectrum of Bath gas. All the prominent lines in the spectrum of the volatile residue of Bath gas were also in that of the residue of atmospheric air except the argon lines. There were, on the other hand, many lines in the latter not traceable in the former, some of them rather conspicuous, such as the ray at about λ 4664. It is, of course, probable that such rays are the outcome of some material not contained in the Bath gas. A very conspicuous pair of lines appears in photographs of the spectrum of the air residue, at about λ 3587, which is not traceable in the spectrum of Bath gas. The helium line, λ 3587·4, is seen in the latter spectrum, but is quite obscured in the former spectrum by the great intensity of the new pair. This helium ray is really a close double, with the less refrangible component much the weaker of the two, but the new pair are wider apart, and of nearly equal intensities; this character also distinguishes them from the strong argon line at λ 3588·6. They are, however, very much more intense at the negative pole than in the capillary, and it will require a good deal more study to determine whether these rays, and many others which we have not tabulated, are due to the peculiarity of the stimulus at the negative pole or to the presence of a previously unrecognised material.

As our mixture of gases probably includes some of all such gases as pervade interplanetary and interstellar space, we early looked in their spectra for the prominent nebular, coronal and auroral rays. Searching the spectrum about λ 5007 no indication of any ray of about that wave-length was visible in the spectrum of any one of the three tubes which had been filled as above described. Turning to the other green nebular line at about λ 4959 we found a weak rather diffuse line to which our first measure assigned a wave-length 4958. The correctness of this wave-length was subsequently verified by measuring with a micrometer eye-piece the distances of the line from the helium lines λ 4922·1 and λ 5015·7 which were in the field of view at the same time. The position of the line was almost identical with that of the iron spark line λ 4957·8, and the conclusion arrived at was that the wave-length was a little less than 4958, and that it could not be the nebular line. There remained the ultra-violet line λ 3727. Our photographs showed a rather strong line very close to the iron spark line λ 3727·8, but slightly more refrangible. As the line is a tolerably strong one it could be photographed with a grating spectrograph along with the iron lines. This was done, and the wave-length deduced from measuring the photograph was 3727·4. This is too large by an amount which considerably exceeds the probable errors of observation, and we are forced to conclude that the nebular material is either absent from our tubes, or does not show itself under the treatment to which it has been subjected.

Although the residual gases of the atmosphere, uncondensed at the temperature of liquid hydrogen, do not show the nebular lines, we found that another tube gave a ray very close indeed to the principal green nebular ray. This tube had been filled with gas prepared in the same way as the others, with the exception that, in passing from the vessel into which the first fraction of liquid air was distilled, it was not passed through a U-tube immersed in liquid hydrogen on its way to the exhausted tube. In consequence it contained traces of nitrogen and argon, and when sparked showed the spectra of these elements as well as those of hydrogen, helium, &c. The nitrogen spectrum disappeared after some sparking, but the tube still showed rays of argon as well as those of the gases in the other tubes. On examining the spectrum of the negative pole in the neighbourhood of the principal nebular green ray, a weak ray was seen in addition to those given by the other tubes. It was found by comparison with the nitrogen rays λ 5002·7 and λ 5005·7 to be a little less refrangible than the latter of these rays, and by measuring its distance from the nitrogen rays and from the two helium rays λ 4922·1 and λ 5015·7 with a micrometer eye-piece, the wave-length λ 5007·7 for the new ray was deduced. This looks as if we might find the substance which is luminous in nebulæ to be really present in the earth's atmosphere, and we hope shortly to be able to verify the observation of it.

Turning to the coronal rays, our tubes emit a weak ray at about λ 5304. This is not far from the wave-length λ 5303·7 assigned by Sir N. Lockyer to the green coronal ray. It is, however, greater than that assigned by Campbell, namely, 5303·26. Other lines observed by us near the places of coronal lines are at wave-lengths about 4687, 4570, 4358, 4323, 4232, 4220, 3985, 3800. These are all weak lines except that at λ 4232, which is of tolerable strength, and that at λ 4220, which is rather a strong line. The wave-lengths 4323, 4232, 4220 and 3800 come very close to those assigned to coronal rays, but the others hardly come within the limits of probable error. The ray 4220 seems too strong in proportion to the others, but the strength of that at 4232 seems to accord with the strength of the corresponding ray in the corona. It will be seen that the rays we enumerate above correspond approximately to the stronger rays in Sir N. Lockyer's list. Further measures of the wave-lengths of the faint lines are needed before we can say definitely whether or no we have in our tubes a substance producing the coronal rays, or some of them.

As to the auroral rays, we have not seen any ray in the spectrum of our tubes near λ 5571·5, the green auroral ray. We have observed two weak rays at λ 4206 and λ 4198, which may possibly, one or both, represent the auroral ray λ 420. The very strong ray of argon, λ 4200·8, would make it probable that argon was the origin of this auroral ray, if the other, equally strong, argon rays in the same region of the spectrum were not absent from the aurora. Nor have we found in the spectrum of our tubes any line with the wave-length 3915, which is that of another strong auroral line. On the other hand it seems probable that the strong auroral line λ 358 may be due to the material which gives us the very remarkable pair of lines at about the place of N of the solar spectrum, λ 3587, which are very strong in the spectrum of the negative pole, but only faint in that of the capillary part of our tubes. It may well be that the auroral discharge is analogous to that about the negative pole. We have also a fairly strong ray at λ 3700, which may be compared to the remaining strong ray observed in the aurora λ 3700. This, however, is a ray which is emitted from the capillary part of our tubes as well as from the negative pole, and is, moreover, emitted by Bath gas, and may very likely be a neon ray.

We hope to pursue the investigation of this interesting spectrum, and if possible to sort out the rays which may be ascribed to substances such as neon and those which are due to one or more other substances. The gas from Bath, even if primarily derived from the atmosphere—which is by no means sure—seems to have undergone some sifting which has affected the relative proportions of helium and neon, and a more thorough comparison of its spectrum with that of the residual atmospheric gases may probably lead to some disentanglement of the rays which originate from different materials. The arrangement of the rays in series, if that could be done, would be a step in the same direction.

The table appended to the above paper is not given here, but it consists chiefly of wave-lengths expressed in four figures only.

THE TREATMENT OF LONDON SEWAGE.[1]

WHEN, some years since, the raw sewage of London was regularly poured into the river in the neighbourhood of the city, the road detritus and putrescible fæcal matter which were delivered in the sewage settled on the river bed and foreshores. The road detritus tended to permanently reduce the depth of the river; while the putrescible matter, arriving faster than it could be removed by the river or could be destroyed by inoffensive bacterial action, accumulated as a deposit on the foreshores and floated in masses of thick scum on the river. It there underwent foul putrefactive changes, rendering the river most offensive to those who navigated it or lived and worked near its banks, and almost intolerable in summer weather, even to those who crossed its bridges. That this result was inevitable will be understood when it is remembered that the sewage consists of the whole of the water-supply and rainfall over the

[1] Abridged from a paper read before the Society of Arts, on December 12, by Prof. Frank Clowes.

metropolitan area which have been charged with varied refuse matters of our streets, our houses, and our manufactories.

The nuisance was removed by taking the sewage fifteen miles below London. Since this was found insufficient, the sewage was subsequently subjected to chemical treatment and sedimentation before it was allowed to flow into the river. The treatment ultimately adopted, and still in vogue, consists in straining or "screening" off the larger solid matters and then mixing the sewage with solutions of lime and sulphate of iron; the chemical precipitate thus produced is then allowed to settle, together with the finer particles in the sewage, by sending the sewage slowly through parallel channels on its way to the river. The settled matter, or "sludge," is sent in tank-steamers to be discharged out at sea beyond the river's mouth; and the fairly clear "effluent" passes constantly into the river from the northern outfall (Beckton or Barking) and the southern outfall (Crossness) in two streams, which jointly deliver over 200.000,000 gallons every twenty-four hours into the river, and which probably constitute the most important tributaries of the lower Thames near London. Since these processes of chemical treatment and sedimentation have been adopted, the foreshores of the river have become clean, the outrageous foulness of the stream has ceased, and those who live on and near the Thames unanimously express their approval of the improvement effected.

It must be remembered, however, that the effluent of the sewage, after it has been freed from visible foul matter, still contains in invisible solution a large amount of putrescible substance, which may, under suitable conditions, lead to serious foulness in the stream. The effluent at present discharged into the river is practically only clarified sewage. As long as putrefactive changes are delayed by low temperature of the river water, and an ample flush of upper river water comes down to dilute this effluent and to carry it rapidly out to sea, no sensible foulness occurs in the main stream. But in summer time, when high temperature hastens putrefactive change and diminishes the amount of oxygen dissolved in the river water, and when the flush of water from the upper river is diminished by drought and by the abstraction of larger volumes of the water by the water companies, the condition of portions of the lower river frequently closely approaches that necessary to cause offence. There can be no doubt that as the volume of sewage effluent increases, and the abstraction of upper river water for water-supply also increases with the increasing population, these portions of the lower river must pass more frequently into a condition bordering upon or actually causing foulness. It is, therefore, prudent to be prepared to adopt without delay a method of treatment of the London sewage which shall meet the requirements of an increasing population, and shall enable the more ample effluent to be discharged into the river in a state of greater purity than is at present secured.

As far back as 1893, the Main Drainage Committee of the County Council, on the advice of their chemist, Mr. Dibdin, started a large scale experiment on the bacterial purification of sewage, the purification being applied to the effluent from chemical treatment and sedimentation. This experimental treatment has been continued by the committee, on my own advice, and has been considerably extended in its scope. The committee also consented to the association of the eminent bacteriologist, Dr. Houston, with me in these experiments during the three years of their progress. The results which have been obtained have been published by the London County Council in the form of a series of reports which I have laid before them from time to time. The general conclusion to which they point is that the settled sewage may be purified to a far greater degree than it is by the present treatment, by encouraging the spontaneous purifying action of the bacteria which are present in the sewage itself. The effluent thus produced, without the intervention of chemicals, remains free from foul putrefaction and is able to support the life of fish; in these and in all other respects it is greatly superior to the effluent which is at present discharged into the river. The minute vegetable organisms, known as bacteria, exist to the average number of 300,000 per drop of sewage. They only require to be placed under suitable conditions in order to effect the rapid and inoffensive resolution of the putrescible matters of the sewage into harmless and inoffensive products.

The general conclusions derived from the experimental bacterial treatment of raw sewage at the out-falls of the London sewage into the Thames are as follows:—

(1) The following results were obtained by treating the raw sewage bacterially in coke-beds. In the process adopted, the sewage was allowed to flow into large tanks which contained fragments of coke about the size of walnuts. As soon as the level of the liquid had reached the upper surface of the coke-bed, its further inflow was stopped, and it was allowed to remain in contact with the bacteria coke surface for two or three hours. It was then allowed to flow slowly away from the bottom of the coke-bed. This out-flowing liquid constituted the "sewage effluent." After an interval of from three to seven hours, the processes of emptying and filling the coke-bed were repeated with a fresh portion of sewage. The coke-bed was at first filled in this way twice in every twenty-four hours, but later on it was filled three and four times in twenty-four hours.

(2) A considerable purifying action has been effected by the coke-bed. This is produced by the introduction of bacteria from the sewage. The maintenance of the purifying action is due to the presence of bacteria or their enzymes upon the coke surfaces, and to the adequate aëration of these surfaces by frequently exposing them to the oxygen of the air.

(3) The oxygen undergoes absorption by these surfaces, and the aëration of even the lowest portions of a deep coke-bed seems to be satisfactory in the above method of working, since the air present in the interstices of the coke, between two fillings with sewage, usually contains as much as 75 per cent. of the amount of oxygen present in the air.

(4) Raw sewage, which had been deprived of its larger particles by screening it through coarse gratings, lost practically the whole of its suspended matter by remaining in such a coke bacteria bed for two or three hours. It appears that the suspended particles of fæcal matter underwent liquefaction by the bacteria, since they did not collect upon the surface of the coke.

(5) The sand and grit and finer mud, arising mainly from the wear of road surfaces, however, were deposited upon the coke surfaces, and gradually reduced the capacity of the coke-bed.

(6) Hair, fibrous matter and woody fibre derived from the wear of wooden street pavements, and particles of chaff and straw mainly derived from the dejecta of horses employed in the street traffic, were also deposited upon the coke surfaces and gradually choked the coke-bed. These substances, which consist mainly of cellulose, are apparently only acted upon by bacteria with extreme slowness under the above conditions. They arrive, however, in a water-logged condition, and rapidly settle down from the sewage if its rate of flow is reduced.

(7) In dealing with the sewage of the metropolis, it seems best to submit the roughly screened raw sewage to a somewhat rapid process of sedimentation, in order to allow these suspended mineral and cellulose matters (5, 6) to subside; and then to pass the sewage direct into the coke-beds. The dissolved matters and the small amount of suspended matters which are still present in the sewage are then readily dealt with by the bacteria of the coke-bed, and no choking of the beds occurs.

(8) The sewage effluent which is thus obtained from the coke-beds is entirely free from offensive odour and remains inoffensive and odourless even after it has been kept for a month at summer heat, either in closed or open vessels. It is clear, except when a turbidity is produced by fine mud particles washed down by heavy rain. Many pond and river fish have been kept in the constantly renewed effluent for a month, and have been found to be perfectly healthy at the end of that period.

(9) The chemical character of this effluent may be briefly indicated by stating that on an average 51·3 per cent. of the dissolved matter of the original sewage, which is oxidisable by permanganate, has been removed by the bacteria, and that the portion which has been removed is evidently the matter which would become rapidly offensive and would rapidly lead to de-aëration of the river water if it were allowed to pass into the river. The above percentage removal (51·3) was effected by coke-beds varying from 4 to 6 feet in depth. A similar bed, 13 feet in depth, has proved more efficient, and has for some time produced a purification of 64 per cent., while an old bed, 6 feet in depth, has given a purification of 86 per cent. A repetition of the treatment of the effluent in a second similar coke-bed has produced an additional purification of 19·3 per cent., giving an average total purification of 70·6 per cent. (*See* Table I.). It should be noted that the above purification is reckoned on the dissolved impurity of the sewage; the suspended solid matter is not taken into account. No difficulty has been found in maintaining this bacterial purification.

TABLE I.—*Relative Impurity as Estimated by Permanganate.*

Raw sewage deprived of its suspended matter ...	3·696	Percentage purification calculated on clear raw sewage.
Effluent from chemical treatment	3·070	16·9
Effluent from single bacterial treatment	1·799	51·3
Effluent from double bacterial treatment	1·137	69·2
River water (high-tide) ...	0·550	—
,, ,, (low-tide) ...	0·429	—

(10) The bacteriological condition of the effluent corresponds in the main with that of the raw sewage. The total number of bacteria undergoes some reduction in the coke-beds, but the different kinds of bacteria which were present in the sewage are still represented in the effluent.

(11) The introduction of such a sewage effluent into the lower Thames is unobjectionable. The river water at the points where the effluent is discharged is uniformly muddy; it is always brackish and frequently salt to taste, owing to the presence of tidal sea water. It is, therefore, not capable of being used for drinking purposes. The effluent would certainly cause no deposit upon the river bed, and would ordinarily tend to render the muddy river water more clear by mixing with it. No offensive smell would be emitted by the effluent as it is discharged into the river. And, although the effluent contains more organic matter than the river water does, the bacteria which it contains would slowly and inoffensively remove this organic matter from the effluent after it has been introduced into the river. The effluent would be suitable for the maintenance of healthy fish-life.

A PRE-COLUMBIAN SCANDINAVIAN COLONY IN MASSACHUSETTS.

THE evidence in favour of a partial settlement of Massachusetts by Scandinavians is gradually accumulating, and in the current number of the *American Anthropologist* (New Series, vol. ii., p. 550), Mr. Gerard Fowke adduces new observations. He says, few persons living among the evidences of Norse occupancy have ever paid any particular attention to them, taking for granted that they are the work of the earlier generations of English inhabitants of the region. Those who give more than a passing thought to these objects of unknown origin can see at once that many features connected with them not only would have been unsuitable for any of the necessities of the latter people, as they were then compelled to live, but could not have been turned to any practical use when completed. Such a conclusion is followed at once by the inference that they must pertain in some way to the social customs in vogue among the American Indians; but it does not require an extended acquaintance with aboriginal remains to convince an observer of the error of this inference, the two classes of works being entirely different in many of their most distinctive characters.

Peculiar to the valley of the Charles river are the hut-sites excavated in the hillsides with their rows or piles of boulders to afford a resting place or foundation for the walls of the structures; the ditches that extend with practically a water level along the slopes of the hills; the dams that obstruct the river and many of its tributaries on both sides; the artificial islands walled or protected with stones; the stone walls along the margin of the streams, between high and low tide—none of these has a counterpart in any known works which can be attributed to Indian habits and life. Of very different character are the extensive earthworks in the bottom-lands; the hill-top fortifications of earth and stone; the immense tumuli of earth or stone, or both combined; and the huge flat-topped mounds of the Mississippi valley, erected by the Indian tribes popularly known as "mound-builders."

Remains of rectangular houses with very thick walls composed of stones and turf have been found of a size sufficient to accommodate several families in the old Scandinavian fashion. The long-houses of the Iroquois and some of the larger houses built

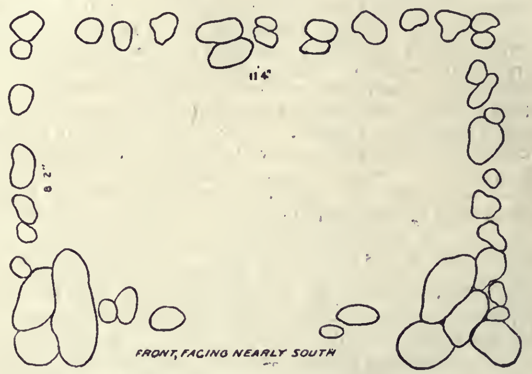


FIG. 1.—House-site above Sibley's, on opposite side of swamp, near Massachusetts Central Railway.

by the Chippewa had the same general form, but with that the resemblance ceases. No foundation was necessary in the Indian house, and it was made principally or entirely of wood and bark. Similarly, nothing at all of Indian origin is known like the cot or hillside huts, of which a number have been examined. These are made by digging back into a sloping surface until a level floor of the desired area is formed; sometimes stones were placed around the sides, in one case (Fig 1) walls of stone and turf were built along the sides. There are indications that such places were covered with timber on which earth was piled.

Near East Watertown is a large natural depression or "kettle-hole." Around two-thirds of the circumference of this, artificial terraces have been constructed, apparently to furnish seats from which spectators might view the exercises or ceremonies which presumably took place on the enclosed level area at the bottom. Somewhat more than a mile south of this "amphi-

FIG. 2 Supposed Norse grave at Clematis Brook, Charles River, Massachusetts.

theatre," at one side of a small area of smooth level bottom-land, a sloping bank rises rather steeply to a height of perhaps thirty feet; along this slope are three or four terraces, not large enough to be of any use for tillage. There is nothing in the eastern part of the United States known to be of Indian origin with which these may be properly compared.

The author describes the various kinds of burial works of the Indians, and compares the numerous cairns found in Massachusetts with Indian stone mounds, but most of these were very much larger than any cairns supposed to be constructed by the Norse. The Indian graves contain skeletons and relics. The stone cairns, the cairns in question, are called graves because they answer, in every particular of size and situation, to those mentioned in different sagas, and are in the midst of various other remains which must be attributed to the Northmen; and yet, in all that have been examined there has not been found the slightest trace of bone or any object which shows the least indication of being artificial. This, however, is only negative evidence; the same statement is true in regard to the graves of Iceland and Greenland; and not only of the graves in these countries, but also of the house-sites. It is also apparent that they differ from Indian graves even more in the manner of their interior construction than in their outward appearance. A. C. H.

PROGRESS OF SCIENCE TEACHING.

THE first report of the newly organised Board of Education has now been published. It consists of three volumes—the first contains the general report of the Board, the second is concerned only with secondary, and the third volume only with elementary education. A very important part of the second volume comprises the reports of the inspectors of the South Kensington branch of the Board of Education, who have charge of the teaching of science and art in different parts of the country. Without exception the inspectors tell a gratifying story of better equipment, improved methods, and saner ideals in the science schools visited by them. But though there has been a decided step forward there is still much to be accomplished and plenty of need for the best energies of both inspectors and teachers.

The reports are full of interesting details, it is true, yet certain broad questions touched upon by nearly every inspector are likely to be of greater general interest. The first of these the senior chief inspector, Mr. Gilbert Redgrave, refers to at some length. Readers of NATURE are already quite familiar with it—the unsatisfactory condition, that is, of the preliminary education of science and technical students in all parts of the country. Mr. Redgrave says: "I find that in a very large number of cases the work of the teacher in an evening class under this Board is crippled and rendered ineffective owing to the backward state of many of the students who enter the classes, and who are really only qualified for the evening continuation school." As Dr. Ball points out, in his report on the work of the South-Western district, the science inspector has no connection with public elementary education and consequently no means of officially acquainting himself with what provision is made for the teaching of science in the elementary school, and there can be little doubt that it is this want of continuity which is very largely to blame for the disparity between what an ex-standard scholar actually knows and what he should be acquainted with if he is to benefit by the instruction of the science class or technical school. Fortunately, local endeavour is doing something to remedy this evil. Mr. Hugh Gordon tells of an arrangement in the county of Durham by which, during the year with which his report is concerned, the County Council refused to grant aid on the attendance of students at a class in a subject unless the students could produce satisfactory evidence to show they possessed the necessary preparatory knowledge, or would attend concurrently such other classes as the teacher considered desirable. Similar instances could be cited, but this example will serve to exemplify what attempts are being made to cope with a real danger to our system of national technical education.

Another subject which very properly takes an important place in most of the reports is the need of practical instruction in all science teaching. There has, the reports show, been a decided improvement in the amount and character of the practical work in all branches of science, except, perhaps, in the case of physiography. In order to enable teachers to illustrate their lessons with properly prepared experimental demonstrations, and to foster individual practical work for their students, they must be given time in which to prepare such lessons. We are glad to see that Mr. Harold Wager calls prominent attention to this fact in his report on the Yorkshire division. He says: "The governors or managers of many of these schools have not yet fully appreciated the fact that teachers of practical science subjects require a considerable amount of time for the preparation of the experiments for their lessons beyond the time actually devoted to teaching. The necessary preparation for a good practical lesson in the laboratory is no light task, and if the work is to be done properly the teacher must have time for it."

Some progress in the direction of co-ordinating the work of the numerous local authorities for education has been made, but there still seems to be considerable misapprehension as to the precise limits of the sphere of influence of each committee or other governing body. It is gratifying to see that broad-minded counsels have prevailed in many centres, with the result that the very large amount of energy thereby saved has been devoted to the improvement of the local supply of scientific and technical instruction. Mr. Redgrave sketches a plan by which the different schools may work together in a satisfactory and harmonious manner. "The Technical School under the Town Council should be a day school for students who have passed through a course of two or three years in a School of Science, which might be conducted by the School Board, and who may desire to qualify themselves for good positions in industrial or commercial pursuits. The School of Science managed by the School Board would in each case be the preparatory school for the Technical School, but it would also provide an education complete in itself for those who leave school at the age of fifteen or sixteen. The evening classes at the Technical School should be classes in connection with the Board, or with the City and Guilds of London Institute, while the evening classes under the School Board should in all cases be those of the evening continuation school, and students should be encouraged to prepare for the classes under the Technical Instruction Committee by a course of study in the evening continuation school." Similar plans have, indeed, been already tried with great advantage in several centres, and it is much to be desired that some such sensible system of co-operation should be universally adopted.

Only part of the science teaching given in secondary schools comes within the purview of the reports under consideration, that, namely, which takes place in secondary schools receiving financial aid from the Board of Education. Mr. Buckmaster deals almost exclusively with this part of the work of the South Kensington branch of the Board. Among other matters which his report makes clear is the fact that there is likely to be some difficulty in the future in those cases where the inspector of the Board of Education and the organising secretary of a County Council Technical Instruction Committee come to different conclusions about a school after inspecting it. As Mr. Buckmaster says, "even in a county area cases may occur where the County Technical Committee will deprecate criticism on the schools it has selected as recipients of its grants."

The points of interest in this very valuable volume have been by no means exhausted by this brief notice. The chief topics only have been passed in review; the interested reader must be referred to the reports themselves for a more detailed account of a vitally important subject.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. ARTHUR ROBINSON has been appointed professor of anatomy at King's College, London.

Science states that in an address to the students of Colorado College, Dr. D. K. Pearsons, of Chicago, announced that on January 1, 1901, he would make the college a gift of 10,000*l* towards the cost of completing the new scientific building now in course of construction.

AT the close of his rectorial address at Aberdeen University on Tuesday, Lord Strathcona expressed his willingness to contribute 25,000*l*. to the University if within a year 50,000*l*. more were raised to complete the buildings and properly equip the University. Mr. Charles W. Mitchell has telegraphed to the Principal that he will be responsible for the whole of the present debt on the University buildings if it does not much exceed 20,000*l*. Mr. Mitchell is a son of the late Dr. Charles Mitchell, who was a liberal benefactor of the University.

A BASE measuring apparatus, which has been perfected in connection with the summer school work of the Civil Engineering Department of the Massachusetts Institute of Technology, has recently been tested by the Coast and Geodetic Survey in Washington. Such satisfactory results have been already obtained that the apparatus is about to be used in the important Lampasas Base in Texas. Prof. Burton, of the Institute, under whose direction the apparatus has been worked out, has been invited to accompany the expedition, which is to make a careful trial of the method in the field and upon extended exact work. The apparatus represents the final results of thesis investigations by several graduates of the course in civil engineering who have worked upon it in successive years. One part of the apparatus maintains a constant tension in the steel tape while in use. Another part of the apparatus determines very accurately the mean temperature of the tape by measuring its electrical resistance by means of a special form of thermophone devised by two graduates.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, December 14.—Meeting held at the Royal College of Science (by invitation of Prof. Rücker), Principal O. J. Lodge, President, in the chair.—A paper on electric inertia and the inertia of electric convection was read by Prof. A. Schuster. Calculations of self-induction are based on the assumption that the currents which traverse a conductor fill it continuously, the flow being treated as that of an incompressible liquid. The assumption is generally recognised not to hold in the case of electrolytes where electricity is conveyed by a number of irregularly distributed ions. In the immediate neighbourhood of such an ion, the magnetic field is many times greater than that calculated on the supposition of continuous distribution, and hence the total magnetic energy is underestimated. What is universally recognised in the case of electrolytes must also be conceded when the current is conveyed by a gas, and the idea is gaining ground that even in solid conductors the current consists of positive and negative electrons moving with different velocities. It is the object of the paper to calculate the additional terms which become necessary for the evaluation of self-induction, and to discuss the possible cases in which the corrections may effect experimental results. The mathematical investigation shows that it is necessary to add a correcting term containing a quantity which may conveniently be called electric inertia. The author has calculated the numerical value of this quantity in the case of a solid conductor, and finds it to be about 2×10^{-12} C.G.S. units. It is of the dimensions of a surface. The experiments of Hertz have proved that if electric inertia exists, it must be less than 18×10^{-8}. In the case of liquids and gases, the electric inertia of the moving ions becomes much more important, and the calculation of self-induction by the ordinary processes gives erroneous results. The introduction of a term representing inertia alters the general equations of electric motion, and the author has applied his modified theory to Leyden jar discharges, the electrodeless discharges of J. J. Thomson, and the electromagnetic theory of light. In the case of electrodeless discharges in a vacuous globe, it is suggested that the absorption of energy may not only be due to the conductivity of the gas, but also to the inertia which it possesses.—A paper on magnetic precession was then read by the same author. The most delicate method of investigating the influence of electric inertia is based on the electromotive forces introduced by the motion of conductors carrying electric currents. If electricity behaves like a body possessing inertia, the rotation of a body through which currents pass should affect the flow of these currents in the same manner as the earth's rotation affects the direction of currents of air. If the earth's magnetism is due to electric currents, it is interesting to see if the effects of inertia can explain the secular variation. The investigation shows that a magnetic precession of the character of the secular variation would be produced, but that the precession would be very much slower than the variations actually observed. The subject is worked out mathematically, dealing first with the case of currents in a spherical shell, and then extending the result to the case of a solid sphere. The calculated period of a cycle comes out as 7×10^{14} years. If the currents are confined to a thin slice of the earth, the time would be reduced to about 14×10^{6} years. To produce the actual period of the secular change, the current sheet would have to be of molecular dimensions. This suggests the possibility of the phenomenon of secular variation being rather of a molecular than a molar character. Prof. Rücker congratulated the author upon his attempt to solve the problem of terrestrial magnetism, and expressed the hope that further calculation would throw more light upon this difficult subject. Mr. Blakesley asked if the time of the secular variation would be altered if the interior of the earth were liquid or solid. The chairman observed that the precession was rapid in the case of a thin layer of gas, and mentioned J. J. Thomson's notion that the electrons were thrown off by centrifugal force and formed a molecular layer. Hertz, in his experiments on electricity, had looked for material inertia besides electromagnetic inertia. In the present theory the distinction disappears, and there is only one inertia, and that electromagnetic. Prof. Ayrton said if the two forms of inertia were electromagnetic, he would like to know why, in detecting the second form, it was necessary to associate it with an absorption of energy, as in the case of an electrodeless discharge. In the case of ordinary self-induction there is no absorption of energy, and if there is absorption in the second form, and if they are both electromagnetic, he would like to know the difference between the two. Prof. Schuster, replying to Mr. Blakesley, said that if the interior of the earth were treated as liquid, the period of the cycle would be about one hundred times less. In reply to Prof. Ayrton, he said he had only cited one experiment to show that a phenomenon, explained by the gas being a good conductor, could also be explained by its electric inertia. It was impossible to say in general whether self-induction caused an absorption of energy or not.—Prof. A. W. Rücker read a paper on the magnetic field produced by electric tramways. Taking the case of a tramway in which the current flows along a trolley wire from the power-house, and returns partly through the rails and partly as earth currents, the author has shown that the vertical disturbing force at any point is due to the currents in the feeders and rails, and that the earth currents affect the horizontal force only. Experiment shows that it is chiefly the vertical force instruments which are affected by the establishment of an electric railway, and since this disturbance is due to the wires and rails it is impossible for an observatory to be protected by rivers or other natural features of the district. A preliminary investigation is based on the assumption that the trolley wires and rails are insulated conductors, and that a fraction of the whole current returns along the rails to the generator. The effect of the railway at a distant point is due to the difference of the current in the trolley wire and the hypothetical uniform rail current, the effect of which at the point considered is equivalent to the actual rail current, which varies from point to point. It is thus shown that the disturbance increases with the length of the tramway, and for a tramway of given length the disturbance is a maximum at points on a line perpendicular to and bisecting it. Experiments made at Stockton on the magnitude of the disturbing force gave, with the vertical force instrument, a leakage of 16·3 per cent., and with the horizontal force instrument a leakage of 15·9 per cent., a fairly close agreement. The assumption that the terminals of the line are above and below the average potential of the earth by the same amount respectively, and that the leakage at any point is proportional to the potential difference between the rail and the earth, leads to the ordinary theory of a Fourier bar. This more accurate assumption has been developed and applied to the results obtained at Stockton. The leakage, as calculated from the amperes and volts, comes out as 20 per cent. The calculation of the disturbing vertical force gives $10{\cdot}5 \times 10^{-5}$ C.G S. units, which is in fair agreement with the value 7×10^{-5} actually observed. In conclusion, it is pointed out that for practical purposes it is sufficient to deal with the average return current through the rails, the formulæ for which are quite simple.—Dr. R. T. Glazebrook read some notes on the practical application of the theory of magnetic disturbances by earth currents. In this paper the author has thrown the extended formula obtained by Prof. Rücker in the previous paper into a workable form, and has tabulated numbers which show at what distances the disturbances are negligible for tramways of different lengths.—Prof. R. Threlfall exhibited a quartz-thread gravity balance. Prof. Threlfall gave a short description of this instrument, which has been described in full elsewhere. He drew attention particularly to its accuracy and portability. Mr. Simpson asked how far the fibre had been calibrated, and

if the instrument would be trustworthy at the freezing-point of mercury. Dr. Glazebrook asked how far the instrument was suitable for Antarctic expedition work. He drew attention to the difficulty of calibrating a new fibre should one get broken in the field. Mr. Appleyard suggested the use of a bath kept at constant temperature with a thermostat. Prof. S. P. Thompson suggested a special meeting to discuss the physics of the Antarctic expedition. Prof. Threlfall said that there was no difficulty in measuring the relation between temperature and coefficient of stiffness down to very low temperatures. A more difficult matter is the coefficient of temperature of the instrument. Shrinkage of the instrument as a whole affects both the fibre and the spring which supports it. The difficulty of a broken fibre in the field can be got over by taking two or three instruments. Working with a thermostat is useful in a laboratory, but decreases the portability in exploration work.—Mr. Watson then exhibited a set of half-seconds pendulums. In these pendulums special attention is paid to the stability of the support. The pendulums are covered by a hood, from which the air can be exhausted so that the logarithmic decrement is diminished. The motion of the pendulums is shown by rays of light reflected from right-angled prisms attached to them, and the period of oscillation is determined by the method of coincidences. For this purpose an accurate astronomical clock is used, and observations are made continuously between two time signals. An accuracy of one part in a million is attainable. In reply to Prof. Threlfall, Mr. Watson said that the knife-edges were on the pendulums, and not on the supports.—The Society then adjourned until January 25, 1901.

CAMBRIDGE.

Philosophical Society, October 29.—The President, Prof. A. Macalister, in the chair.—On the structure and classification of the cheilostomatous polyzoa, by Dr. Harmer. This communication dealt principally with the "compensation-sac," a name given by Jullien to a delicate vesicle lying beneath the front wall of the zooecia of many cheilostomes which have a rigid, calcareous body-wall. This cavity, described by Busk in 1884, and with more accuracy by Jullien four years later, has been looked for in vain or altogether ignored by the majority of recent observers. The compensation-sac is in reality an important organ in lepralioid polyzoa, and Jullien's account of its relations is confirmed.—Observations on the minute structure of the surface ice of glaciers, by Mr. Skinner. By pouring plaster of Paris on the ice surface a permanent cast can be obtained, from which it appears that the porosity of the white superficial layer of a glacier arises from two different causes. The first cause is the melting at the interfaces of the crystalline granules, and the second lies in the formation of small pits by the heat absorbed and radiated from small particles of dust. The two classes of holes are very distinct. Those of the first kind are straight furrows joined to form rough hexagons, and those of the second have a cylindrical or ellipsoidal shape. These pits may occur anywhere on the exposed surface of the crystal, and are like in shape to the larger pits formed by small stones and gravel on the glacier surface. Some other casts have been taken of the surface of the ice formed in ice caverns (glacières naturelles); these show only the melting at the interfaces and no pits. In the glacières the melting takes place very slowly and is due almost solely to the contact of air only slightly warmer than the melting-point.

November 12.—Prof. Macalister in the chair.—(1) The natives of the Maldives; (2) The atoll of Minikoi, by Mr. J. Stanley Gardiner. The Singhalese and Maldivians appear to be the result of dichotomous branching of a common stem, one division proceeding through the Laccadives to the Maldives, the other travelling to its present home along the west coast of Hindustan. Mr. J. Stanley Gardiner's second paper was taken as read. The atoll of Minikoi is situated on a bank extending down from the west coast of India to the south of the Maldives. The atoll has in the past evidently been raised to a height of at least twenty feet above the sea, before which it consisted of a mere ring-shaped reef awash. The land is now very rapidly being eroded on every side. The lagoon is broadening and deepening, and the reef is markedly growing outwards. The atoll probably grew up as a flat reef on some mound on the sea floor, subsequently attaining its present shape. The numerous deep bands of the Laccadives represent incipient stages in the formation of reefs on such mounds, while the islands and reefs exemplify the changes, which finally produce the perfect atoll.

November 26.—The President, Prof. Macalister, in the chair.—Some experiments on the electrical properties of a mixture of hydrogen and chlorine, when exposed to light, by Prof. J. J. Thomson. A series of experiments were made to see whether there is any production of free ions when a mixture of hydrogen and chlorine is exposed to light. If any such production took place it would cause the electric conductivity of the mixed gases to increase when exposed to light. This was tested by placing a small gold-leaf electroscope inside the mixed gas; the rate of escape of electricity was found not to be affected by exposure to light, either in the stage just after the incidence of the light when the mixture expands, or in the subsequent stages when the hydrogen and chlorine are combining. The problem was then attacked from a different side and free ions produced in the mixture by the aid of Röntgen rays or the radiation from thorium; though large numbers of ions were produced they had no appreciable effect on the rate of combination of the gases.—On the leakage of electricity through dust-free air, by Mr. C. T. R. Wilson.—Elster and Geitel have shown that an electrified body gradually loses its charge when freely exposed in the open air or in a room. Their results are in agreement with previous experiments of Linss. They conclude from their experiments that free ions exist in the atmosphere. The experiments described in this paper prove that ionisation can be detected in a small closed vessel containing dust-free air not exposed to any known ionising agents. To eliminate any uncertainty due to leakage through the insulating supports, the system from which the leakage was measured was fixed by means of a small bead of sulphur to a conducting rod passing through the wall of the vessel and kept at a constant potential equal to the initial potential of the leaking system. To reduce the capacity of the latter to the smallest possible amount, the whole system from which the leakage was measured was reduced to a small brass strip with a narrow gold-leaf attached, the deflections of which, read by means of a microscope, served to measure the potential. With a capacity of ·73 centim. there is a nearly constant fall of potential in a vessel containing 163 c.c. of air at atmospheric pressure, amounting to 3 volts per hour, the initial voltage being 220. The rate of leak is the same in filtered air whether the apparatus be filled and used in the laboratory (where contamination with radio-active substances might be formed) or in the country. The leakage takes place in the dark at the same rate as in diffuse daylight. The rate of leak is the same for positive as for negative charges. The quantity lost per second is the same when the initial potential is 120 volts as when it is 210 volts. Such voltages produce the "saturation" current and the rate of leak may therefore be used to measure the ionisation. The rate of leak is to a first approximation proportional to the pressure; at a pressure of 43 millims. the leakage is about one-fourteenth of that at atmospheric pressure. If we take the value found by Prof. J. J. Thomson for the charge carried by each ion, $6{\cdot}5 \times 10^{-10}$ E.U., we can take the experiments as indicating that 20 ions of either sign are produced per second in each c.c. of air at atmospheric pressure.—On a solar calorimeter used in Egypt at the total solar eclipse of 1882, by Mr. J. Y. Buchanan. By means of this instrument, which consists of a modified form of a Liebig's condenser mounted equatorially, the solar radiation collected is condensed 48-fold. Observations made with it show that, taking the radius of the earth's orbit to be 212 times the radius of the sun, the radiation of one sq. metre of the sun's surface is spread over 45,000 sq. metres of the earth's surface, whence the sun must radiate energy at the rate of at least 37,300 horse-power per sq. metre of its surface.—Some theorems in regard to matrices, by Mr. T. J. I'A. Bromwich.—On the rational space curve of the fourth order, by Mr. J. H. Grace.—On *Trifolium pratense*, var. *parviflorum*, by Mr. I. H. Burkill.—The writer has been able to examine plants of this so-called variety from Britain and various parts of the Continent, and to show that it is an abnormality in which the carpels are slightly foliaceous, the corolla crumpled, and with a few secondary modifications in other organs.

MANCHESTER.

Literary and Philosophical Society, December 11.—Prof. Osborne Reynolds, F.R.S., Vice-President, in the chair.—On the thermodynamical properties of superheated steam and the dryness of saturated steam, by J. H. Grindley. The paper contained a review of experiments with steam made by various observers. Some calculations were given which showed the

fallacy of accepting Regnault's linear law for the total heat and latent heats of evaporation of steam as a basis from which to determine the specific heats and other properties in superheated steam. Useful expressions for the products of the cooling effects and specific heat at constant pressure in steam were given, which would be of use for purposes of comparison with actual experiment. Two alternatives were offered in the paper for the true facts in saturated steam—either Regnault's results on the latent heats of steam can no longer be accepted, or the data deduced from experiments in the superheated condition must be rejected, as they cannot be made to agree.—On a new species of *Sepia* and on other shells collected by Dr. R. Koettlitz in Somaliland, by W. E. Hoyle and R. Standen. The new species of *Sepia* (*S. koettlitzi*) was collected at Zeila, nearly opposite Aden. It is most closely allied to *S. singalensis*, Goodrich, from which it differs in having the chitinous margin on the dorsal surface much narrower, and in the inner cone being flattened and (if anything) rather concave and not convex.

PARIS.

Academy of Sciences, December 10.—M. Maurice Lévy in the chair.—M. Painlevé was elected a member in the section of geometry in the place of the late M. Darboux.—Examination of the habits of bees from the double point of view of mathematics and experimental physiology, by M. Abraham Netter. It has been usually held by entomologists that four of the habits of bees are intentional. The author contests this view, and attempts to show that all the movements of bees, without exception, are of the nature of reflexes, the bees being really small living machines working entirely automatically.—Observations of the Leonids and Bielids made at Athens, by M. D. Eginitis. The observations were much interfered with by the weather. On the 14th November only six meteors were seen, on the 15th thirty-six, on the 16th fifteen only. On November 23 and 24 only thirty-three Bielids were seen, mostly of the fifth and sixth magnitude.—Observations of the sun made at the Observatory of Lyons with the Brunner equatorial during the third quarter of 1900, by M. J. Guillaume. The results of the observations are summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude respectively.—Observations of the Leonids made at Rome on November 14 and 15, by M. Rodriguez. Since no observations of the Leonids were reported by M. Janssen, an account is given of the meteors seen at the Vatican Observatory. Details of 107 Leonids are given, for 17 of which the direction during the time of observation was ascertained.—On limited and integrable functions, by M. Léopold Tejér.—On Neumann's method of the arithmetic mean, by M. W. Stekloff.—On the molecular specific heat of gaseous dissociable compounds, by M. Ponsot. Under constant volume or constant pressure the molecular specific heat of a gaseous compound at infinite dilution is lower than that of the mixture of its elements obtained by dissociation.—On the concentration at the electrodes in a solution, with special reference to the liberation of hydrogen by electrolysis of a mixture of copper sulphate and sulphuric acid, by M. H. J. S. Sand. A formula is developed from theoretical considerations for the concentration of a solution of a single salt round the electrodes after passing a current for a given time. In the case of a mixture the formula gives two limiting values between which the experimental values must lie, and the results of electrolysis of solutions of copper sulphate and sulphuric acid in all cases lie between these extreme values.—On the spectra of samarium and gadolinum, by M. Eug. Demarçay. A discussion of the results obtained on these spectra by M. Exner. The wave-lengths are given for the substance regarded by the author as the purest samarium hitherto obtained.—Action of steam and mixtures of hydrogen and steam upon molybdenum and its oxides, by M. Marcel Guichard. Hydrogen completely reduces the oxides of molybdenum to the metal at a temperature below 600° C. Steam, on the other hand, does not commence to oxidise the metal until a temperature of nearly 700° C. is reached. Oxidation of molybdenum either in steam or in mixtures of hydrogen and steam never gives rise to oxides other than MoO_2 and MoO_3.—Remarks on the note of M. Lemoult entitled "Relations between the chemical constitution of the triphenylmethane dyestuffs and the absorption spectra of their aqueous solutions," by M. Charles Carmichel.—On the primitive form of a crystallised body, by M. Fréd. Wallerant.—Quinone, the active principle of the venom of *Iulus terrestris*, by MM. Béhal and Phisalix. It is shown that the active principle of the poison of *Iulus terrestris* contains a quinone, most probably ordinary quinone.—The venom of the *Scolopendra*, by M. S. Jourdain.—On the osmotic pressure of the blood and internal liquids in the cartilaginous fishes, by M. E. Rodier.—Some results of the Belgian Antarctic expedition, by M. L. Kœhler.—On the endogenous formation of the fungus isolated in cancerous tumours, by M. M. Bra.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 20.

LINNEAN SOCIETY, at 8.—On the Structure and Habits of the *Ammocharidas*: Arnold T. Watson.—The Flora of Vavau, one of the Tonga Islands: J. H. Burkill.—Warning Colours in Insects: Prof. E. B. Poulton, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Lecture on the Electrical Engineers (R.E.) in South Africa: Lieut.-Colonel Crompton.

CHEMICAL SOCIETY, at 8.—On the Union of Hydrogen and Chlorine: J. W. Mellor.

FRIDAY, DECEMBER 21.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Use of Geometrical Methods in investigating Mechanical Problems: C. E. Inglis.

CONTENTS.

THURSDAY, DECEMBER 27, 1900.

A CONTRIBUTION TO LAMARCKIAN EVOLUTION.

Sexual Dimorphism in the Animal Kingdom; a Theory of the Evolution of Secondary Sexual Characters. By J. T. Cunningham, M.A. Pp. xi + 317; with 32 illustrations. (London: Adam and Charles Black, 1900.)

HOWEVER much readers of this work may dissent from the views of the author, there can be no doubt that the volume is worthy of the most careful perusal. For the first time since the publication of Darwin's theory of sexual selection we have been provided with a bold and intelligible attempt at explaining secondary sexual characters on Lamarckian principles, and although many of us may arrive at the conclusion that Mr. Cunningham has not succeeded in establishing his case, it will be generally admitted that he has discussed the problem, on the whole, in a more or less scientific spirit, and has supported his arguments by a body of well-considered and, in many cases, original observations, which make his book exceptionally valuable as a storehouse of facts.

The author, as is well known, belongs to that school of anti-Darwinian evolutionists which accepts the broad doctrine of descent with modification, but which denies the sufficiency of natural selection as the cause of species formation. In the introduction he re-states some of the chief difficulties and objections which have been urged, over and over again, by the opponents of Darwinism. An analysis of these objections, as set forth by Mr. Cunningham, will show that they resolve themselves mainly into the inutility of incipient stages, the dictum of Romanes that natural selection is a theory of the origin of adaptations, the inutility of specific characters, the failure of natural selection to account for the origin of variation and so forth. Students of evolution are so familiar with these much-discussed topics that we may be excused from dealing with them again in detail. It is ancient history that Darwin admitted "use and disuse" and the "direct action of external conditions" as factors of some value in the production of species. But he assigned a subordinate function to these agencies, and it is quite unfair to Darwin's position to state, as Mr. Cunningham does (p. 12), that "if once we admit this, selection becomes a secondary and subordinate character."

What concerns us most here, however, is not so much the destructive part of the present work, because the author, in brilliant contrast to many critics belonging to his school, has not contented himself with mere cavil or with the watering-down process which is rife among certain sections of naturalists who regard with horror any attempt at dealing with the species problem by scientific method. Mr. Cunningham has formulated his own views, and has applied them to the particular, and, we may add, absorbingly interesting, class of phenomena presented by animals with dissimilar sexes. These views are, as the author will admit, purely Lamarckian—in fact we might say grossly mechanical, since the secondary sexual characters are regarded as the direct result of mechanical irritation or stimulation (p. 37). It is needless to point out that this view is absolutely at variance with that held by selectionists. It is a doctrine which has been broached of late years to account for floral structures, and which, if we are not mistaken, has received but little favour from botanists.

In defining Mr. Cunningham's position as a Lamarckian, it is necessary to point out, in order that full consideration may be given to his views, that he has introduced a certain modification into that doctrine which he claims—and we think rightly—to be original. Lamarckism, of course, carries with it the admission that acquired characters are hereditary, and the author's attitude towards this question will be considered subsequently. But whereas the original, or proto-Lamarckian, or his modern successor, the neo-Lamarckian, never appears to have troubled himself very much about the precise period in the life of the individual at which the "acquired" characters were produced, Mr. Cunningham has laid it down, as the essential part of his amendment, that these characters only become developed (by heredity) at "that period of life and in that class of individuals in which they were originally acquired" (p. 37). He further postulates that, in order to produce such hereditary acquired characters, the stimulations must "be regularly recurrent," and their transmitted effect is then only developed "in association with the physiological conditions under which they were originally produced" (p. 41). In other words, he re-states Darwin's "inheritance at corresponding periods of life" and "inheritance as limited by sex" from the Lamarckian platform, and imposes a new restriction in the way of "physiological conditions" which are nowhere defined throughout the work excepting in the case of secondary sexual characters, where the supposed conditions are vaguely associated with the change of constitution accompanying sexual maturity.

From these considerations it follows that the external stimulus or irritation which (admittedly) can modify a part or organ of an individual during its lifetime, is only capable of producing modifications of specific rank when applied continuously, throughout many generations, at some particular, and at present undetermined, state of physiological activity. Supposing we admit, for the moment, that the author's position is sound for the only case in which such special physiological conditions are hinted at, viz., the period of puberty, then it follows that those mutilations which have been carried out through successive generations in many tribes of savages at the precisely critical period required by the hypothesis might, at any rate, be expected to show now and again a tendency to appear spontaneously in the offspring at that period. The evidence on this point is certainly against the author, and the case for Lamarckism in its amended form receives no more support by virtue of Mr. Cunningham's amendment than did the original Lamarckism from the consideration of such classes of facts. It is, perhaps, not going too far to say that the author's position is less tenable by virtue of his own restriction than that of the older Lamarckians, because the whole explanation of sexual dimorphism, from Mr. Cunningham's standpoint, is made to depend upon the action of external stimuli applied at the period of breeding, *i.e.* at sexual maturity.

It has already been stated that the author repeats, and therefore presumably gives weight to, the stock objection against Darwinism that that doctrine does not account for the *origin* of the variations which selection has to deal with (p. 30). True; but the writer of this notice is not aware that the selectionists have ever pretended that it did, or that it might be expected to. There have been supplementary hypotheses of variation, and there is reason to believe that variability or instability of form, if of advantage to a species subject to rapid changes of environment, might be seized upon and perpetuated by selection like any other character, structural or physiological. But this has nothing to do with the origin of variation as the result of physiological processes. On the other hand, if the theory of natural selection is considered to break down because it fails to account for the origin of variations (which at any rate are facts) what value can be assigned to a theory which *assumes* a special plasticity of the organism under particular "physiological conditions" at a certain period of its life without any adequate proof that such plasticity does exist, and which further *assumes* that external stimuli, acting upon the individual at that period, produce hereditary modifications of structure?

I hope I am not misrepresenting the author's views in pointing out how much in the way of assumption exists in them. It will, no doubt, be said by Mr. Cunningham that his method is logically sound and scientifically correct. Having come to the conclusion that selection is inadequate to account for the facts of sexual dimorphism, he has a perfect right to ask naturalists to examine the evidence which he considers to weigh in favour of his alternative explanation. He says (p. 42):—

"I maintain . . . that theories of selection being found on application to the facts to be insufficient for their explanation, and the theory of the inheritance of acquired characters being found to harmonise with the facts, we are logically bound to believe that such inheritance does take place, at any rate until some other explanation can be found. I do not concern myself with the question how such inheritance can be produced, *it is a fact that the modifications are hereditary, and my object is to produce inductive evidence that they were determined by special stimulations.*" (Italics the author's.)

The author's position towards the question of the inheritance of acquired characters may be paraphrased thus:—Secondary sexual characters appear to be, on critical examination, the result of direct mechanical action upon the individual; therefore we must believe that these characters have been so produced. The non-transmissibility of acquired characters is not an established truth, but only a belief (p. 15); therefore, in view of the foregoing conclusion, we must believe that acquired characters are transmitted.

In answer to this we can only repeat the statement so frequently made in reply to Lamarckian arguments:—All the evidence hitherto adduced in favour of the view that acquired characters are hereditary is either negative or ambiguous, and in cases where, on such hypothesis, the evidence might fairly be expected to be positive, it is also negative or ambiguous. The probabilities are therefore antecedently against Mr. Cunningham's explanation of secondary sexual characters, and we are justified in asking that his proofs shall be very cogent and convincing before we abandon a theory so probable *à priori* as Darwin's sexual selection in favour of a theory which is based on unproved principles. If the non-transmissibility of acquired characters is not an established truth neither is the opposite view, and the author—outside the domain of sexual dimorphism—adduces no new evidence in favour of this view. He says explicitly (p. 37) that he does not propose to prove that acquired characters are inherited, but a few paragraphs further on he lays down a statement of his own opinion which is tantamount to a declaration that such characters are inherited. It may be well, also, before attempting to deal with the detailed statements contained in the seven chapters following the introduction, to point out once again that the obvious adaptation of the parts of an animal to the life habits is no proof that the structural modifications have been produced by the habits. It may appear, *primâ facie*, that the structure is caused by habit, but this is no proof that it is so caused. The same result can be brought about by selection, and it is quite unnecessary to insist here that this is the essence of the Darwinian theory. But Mr. Cunningham is quite consistently Lamarckian in his inversion of the Darwinian position. Throughout this work the reader will meet with statements which remind us of the old Lamarckism—that such and such a structure *is produced by* such and such habit. In one illustration (p. 171) he even goes so far as to demonstrate that by moving a pen-holder coated with sealing-wax to and fro in hot water the softened wax forms a lamina above and below in the plane perpendicular to the plane of the motion, from which he apparently wishes us to believe that the crest of the male crested-newt "is due to the active movements of the male in courting the female in the breeding season"!

The special evidence which the author brings forward in support of his views is contained in some two hundred and sixty pages, divided into seven chapters, each dealing with the secondary sexual characters of some class or classes of the animal kingdom, from mammals downwards. It is impossible to deal with the various cases in detail, but a few typical examples may be selected in order to illustrate the position of those who, like Mr. Cunningham, regard habit as the cause of structure. The discussion of the sexual differences in man, in the first chapter, will be found particularly instructive. The hair on the face of the male is supposed to be "due to the stimulation of the growth of the hair by teeth or hands in the combats of mature males" (p. 49). That is to say that man's ancestors, by pulling each other by the hair of the face during their struggles for the female, developed a beard and moustache. But if mechanical irritation or stimulation of the hair follicles is the cause of increased growth of hair, why should the hairless condition of man's body, as compared with that of the apes, be attributed to the wearing of clothes (p. 52); the baldness of civilised races to the wearing of hats (p. 53), and the greater length of hair in woman to the wearing of lighter head-gear (p. 54)? Surely the hair follicles of a clothed animal are subject to more pressures and stimulations than in the naked animal? In a similar way,

the author discusses, in this chapter, the origin of antlers, horns and tusks, which, being used for fighting, have, according to his views, been developed by pushes and stimulating shocks. The cheek prominences of the male mandrill are considered to have been produced by a similar process, and their furrows and colour are regarded as "inherited swellings and scars" (p. 58). The case for Lamarckism, as based on a study of antlers, is worked out at great length also in this chapter, this being a subject to which Mr. Cunningham has devoted special attention. The tusk-like development of the upper canines of the male musk deer is explained in these words:

"The enlargement of a tooth is as natural a consequence of excessive use as is that of an antler, the pressure stimulating the papilla or pulp from which the tooth is developed" (p. 96).

The author adds, however, that the evolution of the musk gland of the male "is more difficult to explain."

Those who are familiar with Darwin's weighty body of evidence in favour of sexual selection derived from his studies of the secondary sexual characters of birds will turn with interest to the discussion of this subject in the second chapter of the present work. The excessive development of male plumage is, according to the author, the result of use—*i.e.* to erection by muscular action during display. But the most striking sexual differences among birds are not only due to development of plumage, but also to colour and pattern, and just on this point Mr. Cunningham's application of Lamarckism becomes most unsatisfactory:—

"With regard to the coloration and markings of special plumage I have little to say. I regard them as due partly to the same excessive growth as that which increases the size of the feather, partly to the universal regularity and symmetrical repetition of marks, due to the rhythmical nature of growth processes, and partly perhaps to the action of the light from particular surroundings" (p. 109).

From this point of view, it is interesting to see how the author deals with the ocelli of *Polyplectron* (p. 114). Darwin, as is well known, attributed the dull ocelli of the female to partial transference of the male characters. Mr. Cunningham inverts this explanation, and suggests that the present condition of the female represents the original condition of the male. In other words, the ocelli of the male as at present seen are the female ocelli developed and enhanced by "use inheritance." The writer of this notice fails to see wherein this explanation offers any advantage. The duller ocelli of the female have, on this view, still to be accounted for. What direct action or external stimulus or impact can be conceived which is capable of producing regular patterns? The "action of light from particular surroundings" (even if we admitted such action) could not produce an ocellus, and if the "rhythmical nature of growth processes" is considered a sufficient explanation, this and all similar cases are at once removed from the discussion, and have no more to do with the author's Lamarckism than with the older Darwinism.

The whole treatment of colour and pattern throughout the work leaves no doubt that the author proposes to ring these characters within the domain of his amended amarckism. Among Amphibia, for example, the more vivid colouring of the male *Molge aspera* is attributed to the greater sexual excitement of the male, which causes, "through nervous stimulation, more active production of pigment in the skin" (p. 175). Among fish—a class to which Mr. Cunningham has paid special attention—the same explanation is offered again and again to account for the brighter colours of males. In those exceptional cases where, as in *Solenostoma* (p. 227), the female is the more brilliantly marked and coloured, the author is obliged to reverse the nervous excitement of the sexes. Perhaps the most instructive case dealt with under this division is that of the male dragonet, *Callionymus lyra*, because it is discussed at great length (pp. 199—214), and may be taken as a typical example of the author's treatment of the problem of colour as a secondary sexual character. The habits of the fish have, moreover, been most thoroughly observed and recorded by Mr. Holt at the Plymouth Marine Station. In summing up this case Mr. Cunningham concludes, as before, that the increased sexual excitement of the male at the breeding period causes, through nervous stimulation, an increased deposition of guanine and pigment in the skin.

"That the marked excitement of the male dragonet's brain should cause increased nervous stimulation of the skin is not an extravagant supposition, and it is definitely supported by the fact that the blue bands, if not the yellow, are flashed out in more intense brilliance as the fins are raised in his amatory rushes. When the question is regarded physiologically, instead of merely from the selectionist's point of view, the significance of such reasoning as I have used cannot be ignored."

In this paragraph Mr. Cunningham takes up a position that is very frequently assumed by opponents of the selection theory, and from which the writer of this notice desires to take this opportunity of again expressing his dissent. The fact that the blue bands are flashed out as the fins are raised is surely an optical effect. I can hardly imagine that even the Lamarckian zeal of the author would lead him to desire that his readers should suppose that the "amatory rush" of the male caused an immediate and suddenly increased secretion of guanine! But apart from this, supposing we admit that he has discovered the true physiological explanation of the colour—and that given on p. 211 may be perfectly correct—wherein does this favour the Lamarckian and discredit the Darwinian explanation? It appears to be constantly assumed by anti-Darwinians that because they have found the physiological and histological mechanism of a colour they have thereby disposed of selection. We say that selection is capable of acting upon *all* characters, external and internal—whatever their physiological origin; and, in this particular case, if the male fish were capable at the breeding period of secreting guanine to such an extent and in such an arrangement as to produce a visible blue colour, we should say that there is here a character which is quite as capable of being enhanced and developed by sexual selection as is any other character of biological value to the species by natural selection.

In association with the hypothesis that colour is the result of increased deposition of pigment due to sexual excitement, it may be pertinent here to raise the question why, on Lamarckian principles, the increased secretory

and excretory activity should take the form of colour at all. It can be admitted in a general way that increased nervous stimulus might lead to increased secretion and excretion generally. But there is no evidence of any kind brought forward in support of this—the evidence which Mr. Cunningham asks us to accept in favour of his view centres round *local deposits* either of osseous or horny matter, &c., in the case of mammals, or of pigment. Colour, as such, is meaningless from the Lamarckian standpoint, and we have a right to ask where is the "use" (in the Lamarckian sense) which accounts for the accumulation of such deposits in definite stripes and patterns in one part of a wing or feather. If it be suggested that the definite arrangement is the external expression of an internal law of growth, then the diversity of pattern among allied species remains unexplained; and, if we allow the direct action of light as a cause of pattern, we are invoking an improbable and an unproved principle. It must be presumed that the author considers his experiments on the coloration of the *Pleuronectidae*, to which he refers on p. 41, as a sufficient proof of "the direct effects of stimulations." At any rate this is the only instance specifically mentioned which has any direct bearing on the question of the action of light as a colour-producing stimulus. It appears to the writer, however, that the results which Mr. Cunningham made known in 1896 are open to another interpretation from the point of view of the selection theory, but the discussion of this point would be out of place in the present notice.

If the "nervous excitement" theory of colour is considered sufficient as regards deposition of pigment, the production of colour by purely physical methods, such as striation and lamination, has yet to be faced by the Lamarckian school. This aspect of sexual coloration is very lightly dealt with by Mr. Cunningham, although, in the case more especially of birds and insects, some of the most gorgeous male characters are due to such colours. It is, perhaps, hardly right to attribute unfairness to an author who evidently has done his best to give due consideration to the doctrine which he is opposing, but impartial readers of the present book who happen to be acquainted with the subject at first hand cannot fail to detect the anti-selectionist bias which here and there makes itself manifest in Mr. Cunningham's pages. Nowhere is this more obvious than in the fifth chapter, dealing with the secondary sexual characters of insects. The bias is no doubt unconscious, but when we consider that among butterflies, to which the author devotes the larger part of the chapter, this kind of colouring plays such a very important part, the treatment will be found, to say the least, disappointing by those who wish really to know what the Lamarckians have to say on this subject. The explanation offered is that the colours—pigmentary and physical not being separated—are caused by the direct action of light:

"If we assume that variations in definite directions are excited by external conditions, in this case principally by light of different colours, the facts become intelligible in general," &c. (p. 243).

"By exposure I mean the kind of light to which the surface is exposed, and I believe that in Lepidoptera the coloration has chiefly been determined by the quality of the light" (p. 245).

We do not believe that the author will make many converts to his amended Lamarckism by such explanations as these. When and how does the light act, and how can such action produce pattern? Is the pattern focussed on to the wing by some mysterious agency capable of acting as a lens, or how does the light of different "qualities" (? wave-length) get separated so that each component produces its proper chromatic effect? Upon what organic tissue can light produce such direct photo-chromatic action, and does such action take effect through the skin of the pupa, in which stage the colours, both pigmentary and physical, are formed in the rudimentary wing? It seems to the writer that, instead of the facts being made "intelligible in general" by invoking such strained explanations, they have been rendered hopelessly inexplicable from the Lamarckian standpoint For example, to take his own illustration, does Mr. Cunningham wish us to believe that the hind-wings of *Catocala nupta* have been exposed to red and black light for generations—if so, where is the evidence? Does he seriously believe that the mottled-grey of the fore-wings, which, as he admits, makes them "indistinguishable on surfaces of bark or rock" (p. 246), is better explained by the direct action of the light from such surfaces than by a straightforward admission of natural selection for the purposes of protection? If he does prefer this explanation it must be left for the readers of this review to consider whether any bias is displayed by the author of the work under notice.

In discussing the colours of Lepidoptera, the author begins with those cases in which there is mimicry combined with sexual dimorphism, the females being, generally speaking, the mimetic forms. His object in doing this is to bring into prominence the undisputed fact that in such cases the two sexes have different habits. His contention, of course, is that the habits have produced the differences between the sexes. But if we do not admit this—and selectionists will not accept this doctrine until some much stronger evidence is forthcoming—the whole force of the argument is lost, because the difference in habit is also precisely in harmony with the requirements of the selection theory. What is really wanted to make this argument of any value is the proof that in species which are *not mimetic*, but which are nevertheless sexually dimorphic, there is a sufficiently marked difference between the habits of the sexes to account for the greater brilliancy of the one sex. So far as the writer has observed, there is no marked difference of habit leading to different exposure, for example, between the male and female in species of *Colias*, *Anthocharis*, *Pieris*, *Gonepteryx*, *Hipparchia*, *Satyrus*, *Argynnis Hesperia*, &c. Yet in all these there is in most of the species a marked dissimilarity of sex. To narrow down the issue, why, on Lamarckian principles, should the male orange-tip (*A. cardamines*) have an orange patch on the fore wings, and the female *Colias edusa* a row of orange spots round the black border? Why should the male *Gonepteryx rhamni* be bright yellow and the female greenish-white?

In all cases where direct observation is wanting, or where there is no observable difference of habit between the sexes, the author assumes that there must be some such difference. Of course this is a very easy way

of "explaining" things by Lamarckism or any other hypothesis; but as this method is freely indulged in throughout the book, and since Mr. Cunningham is nothing if not logical, it may be well to examine a little more critically his position in this respect. The kind of assumption to which reference is made is well illustrated, not only by the chapter on insects, where colour is chiefly dealt with, but also in other classes where structures of unknown use are possessed by the males. Thus, among birds, the males of *Chasmorhynchus nudicollis* and other species of the genus are supposed, without evidence from observation, to fight and to

"seize their adversaries by the skin at the base of the beak, the attack being directed to the chin or the forehead, according to the species" (p. 145).

This is put forward as a "probable conjecture," because the male characters require such Lamarckian stimulations to account for their presence. Among chamæleons, the male, *C. Owenii*, has three slender horns which are not known to be used for fighting;

"but the animals are known to be quarrelsome, and it is probable that the appendages are thus used" (p. 166).

In this case the author even allows his logic to go by the board, because he follows up this statement, which is only conjectural, with the remark:

"Here again, therefore, we find that the existence of outgrowths corresponds to the impacts produced by definite actions, both being confined to the male sex."

That is to say, that a function which is conjectured to be probable in one sentence is treated of as an established truth in the following sentence. Examples of this kind might be multiplied, but the foregoing will suffice. Now the point which the writer of this notice wishes to urge is that all the arguments of this class are arguments of analogy only, and the weight which attaches to them is dependent on the antecedent probability of the hypothesis in support of which they are brought forward. Mr. Cunningham has, by implication, admitted the antecedent probability of Lamarckian factors; but if we do not follow him—and no selectionist will—much, if not all, the force of the analogies is lost, and we have a right to demand proof of actual connection between male structures and their use in every case described by the author. It is not to the point, in such cases, to urge that because in one species the male has been seen to use appendages or excrescences for fighting, therefore in other species with similar growths these must be used for the same purpose. The theory of sexual selection allows that male characters of the kind referred to may have been developed for ornament or as weapons of attack or defence, or for both purposes. But Lamarckism must have a definite mechanical cause for each excrescence or appendage, and the failure to discover such cause in any particular case is so fatal to the doctrine that most impartial readers of Mr. Cunningham's work will, on this ground alone, reject his conclusions. In one case (*Turnix taigoor*, p. 118) where the females are known to fight, and where there is no modification of structure corresponding to this habit, the author suggests

"that the pugnacity of the females has but recently arisen in the evolution of the genus, but it may be that the wounds inflicted are not very severe" (p. 120).

Many other points in the volume under consideration are open to criticism, and, in view of the importance of the issues, demand notice. Reverting again to the chapter on mimicry, the author, in rejecting the obviously simple explanation offered by selection for protective purposes, says that

"the theory of specific mimicry involves assumptions that have not been sufficiently realised. It assumes that birds or other enemies of butterflies are as precise in entomological discrimination as the human specialist" (p. 241).

This is hardly a correct statement of the case; the assumptions made by the theories of mimicry (Batesian and Müllerian) have been thoroughly well realised, and a body of evidence, both observational and experimental, has been brought to bear upon these theories, which Mr. Cunningham has either overlooked or chooses to ignore. But his own assumption, which precedes this statement, displays such an astonishing misapprehension of the whole subject that we can only come to the conclusion that the author has not really made himself master of the theory which he is endeavouring to overthrow. Having admitted that mimicking forms may belong to persecuted groups, he still suggests that, after all, the mimics may not owe their safety entirely to deceptive *appearance*, and he then goes on to say:—

"Inedible forms, such as the Heliconidæ, the gooseberry caterpillar and others, are distasteful largely in consequence of the presence of the pigments which make them conspicuous. *Therefore when a mimicking form acquires similar pigments it probably likewise ceases to be palatable to insect eaters*, and would be equally unmolested even if it possessed no particular resemblance to a species of another family" (p. 241. Italics ours.)

It really appears from this as though the author believed that the mimicry extended to similarity of pigment, which is not only contrary to the truth, as established by the researches of Mr. Gowland Hopkins, but is in itself so improbable *à priori* that it is surprising that Mr. Cunningham should have committed himself to the statement.

Considered as a whole, there can be no doubt that this fifth chapter is the least satisfactory in the book. It not only contains misstatements such as the above, but its omissions show that the author has not made himself acquainted with the recent developments in this direction. As the Arachnida are not considered at all, the splendid observations of Mr. and Mrs. Peckham on the courtship of spiders are not discussed. The reference to Poulton's experiments on the influence of the colour of the surroundings on the colour of the larva and pupa, as an illustration of the modifying action of the "quality of the light" (p. 231) upon the colour of the wing of a butterfly, is a false analogy. The statement (p. 248) that "the beauty of a butterfly's wing is equally visible whenever the insect flies" does not convey the whole truth, because in many of the most gaudily coloured males the full splendour of the colour is only seen from the front aspect, *i.e.* facing the insect and looking across the

surface of the wing, the aspect that would be first seen by the female if the male were flying straight towards her. Nowhere is this iridescent colouring better seen, by the way, than in the male *Hypolimnas bolina*, figured by the author on p. 233.

Although there can be no doubt that Mr. Cunningham's plea for Lamarckism and the inheritance of acquired characters is on the whole very ably supported, it will not fail to strike many of his opponents that his anti-selectionist zeal carries him too far in some of his most fundamental arguments. Like many of the recent critics of Darwinism, the author now and again reads into the theory of selection certain deductions of his own, which he then proceeds to demolish without considering whether his deductions are legitimate or not. For example, he considers it an objection to the Darwinian explanation of flying mammals (p. 15) that

"the variations in the condition of the skin in animals that do not fly or take long leaps through the air are not such as to justify the belief that these variations would make any difference in the struggle for existence when long leaps became necessary."

That is to say that other animals besides those that do fly might be expected to show, on occasion, the raw material, so to speak, for potential flight. This is a kind of argument which has constantly been used by anti-Darwinians. Why, because a certain species has been enabled to develop such and such a useful character, have not similar characters been developed in other species to which they might be equally useful? It appears to be again necessary to point out (1) that it is not part of the Darwinian theory to suppose that every species is capable of varying *in every possible direction*; (2) that modification in the direction of flight may not have been possible in the species which "do not take long leaps through the air"; and (3) that such species have, no doubt, survived by the development of some other method of escape or defence which is quite as effective. Arguments of this sort might equally well be urged against the Lamarckians. Why, for instance, do not the flying lemurs, squirrels and foxes, &c., fly as well as bats, seeing that the membranous expansion of skin is constantly being used for gliding through the air? The writer has no desire to press this point against the author of the present work.

Then, again, Mr. Cunningham insists frequently that his (Lamarckian) explanation accounts for unisexual inheritance, while sexual selection does not. I believe that I shall not be singular in declaring my inability to see any force in this argument. Inheritance, as limited by sex, is a fact. Mr. Cunningham says (*e.g.* on p. 252) that this limitation is due to the "stimulations" having been applied to one sex and not to the other. But even if this were the true origin of the male characters there is absolutely nothing in the Lamarckian explanation which accounts for their non-transmission to the female. All characters, whether secondary sexual or not, must on either hypothesis (Lamarckian or Darwinian) originate in an individual, which individual must—it is needless to say in the case of bisexual animals—be either male or female. Why, then, should there ever be any blending of characters at all? According to Darwin's theory, the male characters originate through the selection of spontaneous variations by the females; according to the amended Lamarckism, the male characters are, as it were, hammered out of the male by stimuli applied at the period of sexual maturity. Why should this latter view be supposed to account for the limitation of the male characters to the male, and the former view (Darwin's) to fail? Or, to put the case in another way: Why should characters impressed mechanically upon the male during a particular period of his life be hereditary, and characters arising by spontaneous variation at that period not be hereditary? If the author had contented himself with the acknowledgment that unisexual inheritance required further explanation, both schools of biologists would agree. The selectionists might even have suggested an answer on the lines laid down by Wallace—that the female, being in most cases in greater need of protection and concealment, had had any tendency to inherit the male characters eliminated by natural selection. The author will no doubt reject this explanation; but whether he does so or not, it is manifestly absurd to claim for Lamarckism a fictitious superiority as regards the explanation of unisexual inheritance. The advantage seems to the writer to be distinctly on the side of the Darwinians.

If, as we believe, this latest attempt to reinstate Lamarckian evolution is unsuccessful, its failure is due to the inherent weakness of the doctrine rather than to the treatment which it has received in the present volume. It was an excellent idea on the part of Mr. Cunningham to test this theory by applying it to secondary sexual characters, but it does not appear that the light shed by Lamarckian assumptions is in any way clearer than that offered by the theory of sexual selection. There are, confessedly, difficulties in the way of both theories, but those offered by the Lamarckian doctrine are certainly the more serious. The writer, at any rate, has come to the conclusion that few biologists in this country will accept the mass of material offered in the present volume as "inductive evidence" in favour of the heredity of acquired characters. Most of the cases discussed are equally well explained by the theory of selection—some cases are better explained by this theory. Assumptions and deductions have to be made by the supporters of both theories; those required by the Lamarckians seem to be much the less warrantable. It may be fairly said that if Lamarckism breaks down in its application to such characters as those dealt with, its career as a working hypothesis has ended fatally. It would certainly be interesting to know whether the author limits his Lamarckism to the production of secondary sexual characters, or whether he regards his amended form of the theory applicable to *all* specific characters. Limitation hardly seems possible logically, because any stimulus or impact of any kind whatever must (on this hypothesis) produce its effect if applied at the right stage of physiological activity. The author, if he accepts this wider application, will thus have narrowed down the issue between the two schools of evolutionists to the simple question whether hereditary modifications can be produced by such means. We believe the answer will be in the negative, but if this wider view is not accepted, then Mr. Cunningham must show cause why the modification should be restricted to such characters as those which he has so ably discussed in the volume which has been considered in this notice.

R. MELDOLA.

OPTICAL SCIENCE.

A Treatise on Geometrical Optics. By R. A. Herman, M.A., Fellow of Trinity College, Cambridge. Pp. x + 344. (Cambridge: University Press, 1900.)

IN the preface to a recent book dealing with photographic optics, Prof. S. P. Thompson expressed the view that Sir John Herschel's article, "On Light," in the "Encyclopædia Metropolitana" of 1840 marks the culminating point of English writers on optics. Whether this is still the case or not perhaps need hardly be discussed; it may safely be said that Mr. Herman's book, which contains many novel points, constitutes a marked advance, and brings before English students a quantity of information which was not easily accessible to them before.

At the same time, the book undoubtedly suffers as a treatise on the subject from being a text-book for mathematical students at Cambridge. Mr. Herman has aimed at attracting a wide circle of students. The most elementary proofs of the simplest theorems are given alongside of mathematics which require a considerable training to follow easily. The book would have gained as a treatise if the author had assumed his readers to possess some elementary knowledge of the subject and its simplest formulæ. A Cambridge coach might put it in the hands of a beginner, marking, say, two-thirds as to be omitted at first reading; that two-thirds, with some slight re-arrangement and addition, would make a more interesting book for the more advanced student than the actual volume now under review. Thus the theory of geometrical foci, the methods of constructing a figure to find the image of a small object placed perpendicularly to the axis, of a system of spherical reflecting or refracting surfaces and similar problems could all be put more briefly.

In Chapter ix. (General Theorems) we come to Fermal's theorem; the general theory of geometrical foci is here given, based on this theorem. The author remarks that all the theorems hitherto obtained for small pencils passing directly through a coaxial refracting system might be obtained from the formulæ arrived at; the advanced student would have gained a closer grip of the subject as a whole had this course been taken. The formulæ can be extended to establish the collinear relation between the object space and the image space, and, when once this is done, the existence of the principal and nodal points follows, and the geometrical constructions based on a knowledge of their position are easily generalised. The introductory methods of Drude's recent "Lehrbuch der Optik" seems, in this respect, more suited to a treatise on the subject than those chosen by Mr. Herman, who appears to have been deterred from using them by his wish to make it clear throughout that the method of geometrical foci is only an approximation. But in spite of this the merits of the book are very great. The author, in his introduction, states that it has been one of his aims

"to introduce a new method of determining the properties of a symmetrical optical instrument in which the angle of divergence of a small pencil, rather than any coordinate of its origin, has been adopted as a leading feature."

The method rests on a combination of Cotes' theorem of the apparent distance, and Helmholtz's expression for the linear magnification.

The simplification that results from its use in the case of a symmetrical pencil traversing a coaxial system of lenses is most marked; the lengthy calculation of the continued fraction by means of which the results are arrived at in Gauss's treatment of the subject is entirely avoided. The application of the method to the determination of the axial aberration of such a system is a striking example of its power; this is easily seen by comparing Chapter viii. (Aberration) with the corresponding portion of some earlier text-book.

In the chapter on instruments the discussion of telescopes is very satisfactory. The same can hardly be said for that on microscopes; probably it would be too much to expect an explanation of the complete theory within the limits of space which could be assigned to the subject, but the discussion should have come after the chapters on aberration and achromatism; it would then have been possible to refer to the problem of the manufacture of suitable glasses which Abbé set himself to solve in 1881—this is alluded to in a perfunctory manner in § 123—and to indicate in a general way the outlines of the theory and the methods in which the defects of one lens are corrected by the next.

The problems to be solved in the construction of photographic lenses can, perhaps, hardly be discussed fully without more complete calculations of the aberrations of oblique pencils than is possible in a general treatise; still, space might have been found for a reference to von Seidel's work, and some discussion of the physical meaning of his five equations of condition would have been interesting and valuable even if the reader had been referred to the original papers for a proof of the conditions. In fact, the book would be improved in many places if the account given of modern German work were more complete; in the chapter on achromatism, for example, full details are supplied of the refractive indices and dispersive powers of several specimens of crown and flint glass; details as to Abbé's glasses, which contain salts of boron, phosphorus and barium, together with some note as to the effects produced on the optical properties of the glasses by these salts, might well have been added. The book is so notable and valuable an addition to the literature of a rather neglected subject, that it is a pity it is not more complete in these respects. It is printed by the Pitt Press in its usual admirable style; the collection of examples, both worked and unworked, is specially full, and will be found very useful to the student. As a text-book it is a marked advance on anything yet published in England.

OUR BOOK SHELF.

By Land and Sky. By the Rev. John M. Bacon, M.A., F.R.A.S. Pp. viii+275. (London: Isbister and Co, Ltd., 1900.)

MEMBERS of the British Association who were at the Dover meeting may find in this book, among other things, some account of the intentions and the performance of the balloon that occupied for so long a time the grounds of Dover College.

Whether the book was intended to be the British counterpart of its ponderous contemporary in three volumes recently issued by the Aëronautical Society of Berlin does not appear from anything that is written therein. It deals with the same large subject—scientific balloon voyages—but it is not a work of reference. It could hardly be so, for it has no index, and the table of contents serves more to stimulate curiosity with attractive head-lines, as "Marooned" and "How I bombarded London," than to guide the reader to any scientific results. It is not even effective as an indication of what is to be found in the chapters, for what the author has to say, for example, on the natural history of gorse and bracken is to be found in the chapter headed "fog signals."

The leading motive of the book, in so far as it is not autobiographical, is the application of balloon observations to certain problems connected with the transmission of sound, and this leads to spending midnight hours on a tower of St. Paul's, to a long stay at the Maplin Lighthouse, and other eerie expeditions, but to no effective scientific results except the destruction of the author's belief in aërial echoes.

The book has, in fact, all the discursiveness of the *dilettante*. Its scientific investigations lack the definiteness which quantitative measurements give. It describes in one chapter how a certain echo always arrived behind time, but it does not say how the time-table was drawn up. Still, it deals with a number of interesting balloon excursions and the adventures that they afforded; the style is racy in its way, the illustrations are good, and the printer has given effective assistance. The reader will at least learn that ballooning is still in the adventurous stage, and, if he thinks about it, he will conclude that some scientific methods are better than others.

Der Aufbau der Menschlichen Seele; Eine Psychologische Skizze. Von Dr. H. Kroell. Pp. v+392. (Leipzig: Engelmann, 1900.)

DR. KROELL'S work might be judged from two very different points of view. As a popular and generally intelligible account of the present state of our knowledge as to the localisation of function in the brain and the stages of cerebral development, some of his chapters may be highly commended for their clearness and accuracy. As a "psychological sketch" of human life and thought, written with the avowed object of establishing the materialist position, the book is an unqualified failure. Dr. Kroell brings out materialism in his results simply because he has put it into his premisses. He is content to assume the first principles of mechanical physics, not, as a real physicist might do, as working hypothesis, but as unquestionable and ultimate truth. Moreover, he states even those principles in an unsatisfactory way. The difficulties which beset the problem of the relation of matter and energy are ignored by the convenient device of asserting that each is one aspect of a double reality which the author calls "Kraft-stoff"; unfortunately he omits to tell us how "Kraft-stoff" is to be measured. He assumes, with equal recklessness, that all energy is kinetic (p. 28) and (pp. 30, 31) that the phenomena of life *must* be capable of being adequately described in terms of rotatory motion. Dr. Kroell's psychology is of the same type. He can see no difference in principle between the photo-chemical changes produced on the retina by a light-stimulus and the transformation of molecular motion into consciousness which, on his theory, take place in the cortex. The "picture in the brain" is a reality of the same order as the "picture on the retina." That neither "picture," as distinct from its physical conditions, exists except for the eye of an observer does not occur to him. A sensation (p. 70) is actually said to be a cerebral process which has become "conscious of itself," though, of course, our own cerebral processes are in point of fact precisely that of which we are *never* directly conscious. The sensation as a mental state is confused with its own cortical concomitants and baptised by the name of "picture in the cortex" (p. 98); and the unmeaning question has then to be discussed how it comes about that the "picture in the cortex" is "referred away outside" to the periphery of the body or to a spot in the external world. The questions of animal psychology, which all serious students of the subject know to require the most cautious handling, are settled by Dr. Kroell in the same spirit of jaunty confidence. For instance (p. 125), the higher animals have memory-images. This is roundly affirmed without evidence, apparently in utter ignorance of the actual experimental work which has been done in the study of the animal mind and the much more guarded conclusions to which that work points. Animals (*ib.*) have "concepts," though no word is said as to the evidence which has satisfied the author upon this thorny and debated subject. These are but a few specimens of the confusions of thought and reckless assertions with which the book abounds; they should be enough, however, to indicate the worth of an argument for materialism founded on such premisses. Psychologists have no right to quarrel with physiologists and medical men for not being themselves psychologists; they surely have a right to expect that psychology, as much as any other science, should be protected against the dogmatism of outsiders who disdain to make themselves acquainted with its problems and methods. No knowledge of physiology can give its possessor the right to dogmatise *à priori* in physics and in psychology.

A. E. TAYLOR.

Shakespeare's Greenwood. By George Morley. Pp. xx + 289. Illustrated. 16mo. (London: D. Nutt, 1900.)

OF this daintily turned out volume, some portions have already seen the light in an abbreviated form in the columns of *Knowledge*, *Country Life* and the *Art Journal*, but the greater part is new. And the author, who is already known to the public by other descriptions of Warwickshire scenery, claims for his present effort the position of being the only work that deals with the survival of old-time feeling and custom in Shakespeare's country.

Naturally the work is in the main interesting to the antiquarian, the philologist and the student of folk-lore rather than to the zoologist; but there is a chapter on birds from which the ornithologist may possibly glean a few facts in regard to habits and local nomenclature. As an example, we may refer to the incidental statement on p. 194 to the effect that the name "landrail" (like corncrake) is derived from the cry of the bird to which it is applied. It may be that this derivation, although previously unknown to ourselves, is familiar to ornithologists, but we have failed to find mention of it in three standard works on British birds.

The popular superstitions connected with the redbreast and the wren are sympathetically referred to on pp. 153 and 154. And an old-time belief connected with egg-shells is detailed on p. 173. It appears that in Warwickshire it is the custom to scrupulously preserve these, although, at the pain of ill-luck, on no account should they be kept in the house. "But if by any mischance," says our author, "some person, unacquainted with the folk-lore of the subject, should burn the egg-shells, then, in the rustic belief, the hens will cease laying. Where this faith is the strongest is in the isolated homesteads on the waste or by the side of a wood, and there the utmost care is taken to prevent any single egg-shell being thrown into the fire, so that the fecundity of the hens may be stayed." It would be very curious to discover the origin of this and many other strange superstitions referred to by Mr. Morley.

To those of our readers interested in folk-lore, as well as to all Shakespearian students, the elegant little work before us may be heartily commended.

R. L.

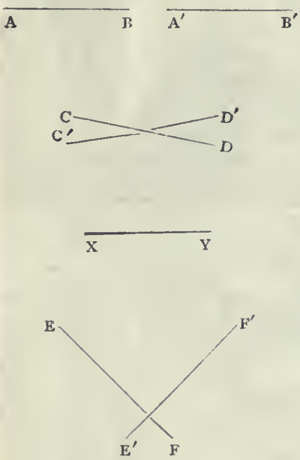
LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relative Motion of the Earth and the Ether.

IN recent issues of NATURE and the *Philosophical Magazine*, Profs. Larmor and Fitzgerald and Lord Kelvin have expressed themselves as if satisfied that the negative result of the celebrated Michelson and Morley experiment as to a relative motion of earth and ether is genuinely decisive, and as if the only present escape from the dilemma between this experiment and the bulk of the evidence which necessitates a relative motion of earth and ether is to be found in a possible change of the dimensions of bodies caused by changes in their motion through ether.

I should like to point out that a much less heroic alternative is offered in an article of mine on relative motion of earth and ether in the *Phil. Mag.*, January, 1898. It is there shown that the optical apparatus used by Michelson and Morley was probably in a less sensitive condition than was assumed, and, therefore, failed to determine the very minute distance which was the subject of measurement in their experiment. The argument of my paper can be illustrated by the following considerations. Let AB be a source of light, and let A′B′ be a duplicate of it, for example AB and A′B′ may be the two images in Fresnel's production of interference fringes by a biprism. The distance apart of the fringes at any place is inversely proportional to the distance between AB and A′B′.



But if, instead of a duplication such as AB and A′B′, we have one such as CD and C′D′, then an eye at XY can see fringes whose width depends on the angle at which CD is inclined to C′D′. These are two simple limiting cases with correspondingly simple laws. Michelson and Morley assume that their apparatus gives them the case of CD and C′D′, but there is nothing in the arrangement of their apparatus to ensure that the case shall not be like that of EF and E′F′, where the two images have suffered both the angular displacement of CD and C′D′, and the lateral displacement of AB and A′B′. The law of the width of the fringes due to EF and E′F′ must be such as will include the laws of AB and A′B′, and of CD and C′D′ as limiting cases. I hold, therefore, that the Michelson and Morley experiment is vitiated by the assumption that their apparatus gave them the full sensitiveness of the CDC′D′ position, whereas it really gave the unknown smaller sensitiveness of the EFE′F′ position.

They found that the displacement which they measured was probably less than a fortieth of what might be expected as due to the earth's orbital motion. I maintain that a possible alternative to this conclusion is that the sensitiveness of their apparatus was probably less than a fortieth of what they assumed it to be.

On account of the great importance of the subject it is very desirable that this experiment should be repeated with a definite experimental measurement of the actual sensitiveness of the apparatus employed. It would be indeed a great help in astronomy if we could have Michelson and Morley apparatus of known adequate sensitiveness in our observatories furnishing continuous record of the earth's motion relative to the ether, from which we could calculate the drift of the solar system, and ultimately express all stellar movements with reference to the ether. WILLIAM SUTHERLAND.

Melbourne, November 6.

Virgil as a Physicist.

IT seems to have escaped observation that, just as Homer appears to have known of, and even given names to, the two attendants or satellites of Mars, so Virgil is the earliest to mention that now familiar substance, "liquid air." In proof of this I may cite the following passages:—

(*a*) Georg. i. 404 (a meteorological passage, describing various signs of fine weather).

Apparet liquido sublimis in aëre Nisus.

"Nisus (the hawk) is seen high up in the liquid air."

(*b*) Æneid vi. 202 (where the author is speaking of the sacred doves which conducted Æneas to the golden branch which was to be his "open sesame" to the infernal regions).

Tollunt se celeres, liquidumque per aëra lapsæ
Sedibus optatis geminæ super arbore sidunt.

"Swiftly they soar aloft; then, dropping through the liquid air, together settle on the wished-for tree."

Virgil does not seem to have made any scientific examination of the substance he terms "liquid air"; but he must have noted its transparency since he makes a point of the visibility of birds through a thick stratum of it, and in the second passage he evidently considers (whether from actual experiment or not must be uncertain) that immersion in it had no effect on the "conducting power" of Venus's doves. H. G. M.

The Sentinel Milk Steriliser.

A RECORD of certain observations upon the action of the "Sentinel" steriliser is given in your issue of December 13 (p. 166).

The results of the temperature determinations are there stated as follows:—

		Bell Form.		Cut-off Form.
Water	Half pint	94° and 95° C.	....	95° and 93° C.
	One pint	87·5° ,, 89°	....	86° ,, 87°
	Two pints	87° ,, 86°	....	84° ,, 85°
Milk	Half pint	98° (frothing)	....	95°
	Two pints	87°	....	84°

and your reviewer adds: "It will thus be seen that there is considerable variation in the temperature."

We trust that you will allow us to point out that the instrument used was of the size designed for the sterilisation of *two* pints of milk. An inspection of the above table proves that the apparatus worked in a satisfactory manner even when *one* pint only was placed in the vessel (the temperature readings being 87° to 89° in the bell form and 86° to 87° in the cut-off apparatus), and also that when the proper volume of liquid was inserted, the variations in temperature were still further reduced.

As the apparatus is purposely made in different sizes, and as it was at no time supposed that any one size would be used with but one-quarter of the correct volume of liquid, the conclusion that "there is considerable variation in temperature" certainly conveys a wrong impression to the reader.

Your reviewer appears to doubt the wisdom of selecting temperatures in the neighbourhood of 85° C. Now it is generally acknowledged that Prof. Bang, of Copenhagen, is one of the leading authorities on this subject, and therefore we give the following passage from Scurfield's translation of Nocard's "Animal Tuberculosis" (p. 73).

"The extremely well-conducted experiments of Bang have established the fact that the bacilli of tuberculous milk are destroyed with certainty when the milk is heated to 85° C. for five minutes; between 75° and 80° they are sometimes killed, but not always; they resist a temperature of 70°, and are afterwards able to render guinea-pigs and rabbits tuberculous when inoculated into the peritoneum; but their vitality is lowered, and they are no longer able to resist the action of the digestive juices of those animals. At 60° their virulence does not seem to be modified. Galtier has obtained results almost identical with those of Bang."

It is worthy of remark that one practical application of these investigations is to be found in Denmark, where the law compels all dairies that return unconsumed milk to "heat this milk to 85° C. for a short time, and then rapidly cool the same."

(For the Cambridge Sentinel Manufacturing Co., Ltd.),
D. BERRY (manager).

IN the directions for use issued with the "Sentinel" steriliser, it is not stated that the apparatus should be filled or thereabouts; in consequence the variations in temperature with different volumes were tested. It may not always be convenient or

requisite in the household to sterilise the full amount, and unless explicit directions on this point are given, smaller quantities will be treated, with the result indicated. With regard to the thermal death point of the tubercle bacillus, I am acquainted with the researches of Bang, Galtier, de Man, MacFadyean, and others. Undoubtedly 85° C. is a safe temperature, but the claim that the milk is unaltered in flavour and nutritive qualities thereby cannot be substantiated. In view of Theobald Smith's most careful work, which, so far as I know, has not been challenged, it seems that, provided the milk be heated in a closed vessel so that no skin forms on the surface, pasteurisation at 68° C. for 20 minutes will kill the tubercle bacillus with certainty, and this treatment but slightly alters the flavour of the milk. It may be wise to select the higher temperature, but it should not be stated that the milk is practically unaltered thereby.

YOUR REVIEWER.

TYCHONIANA AT PRAGUE.[1]

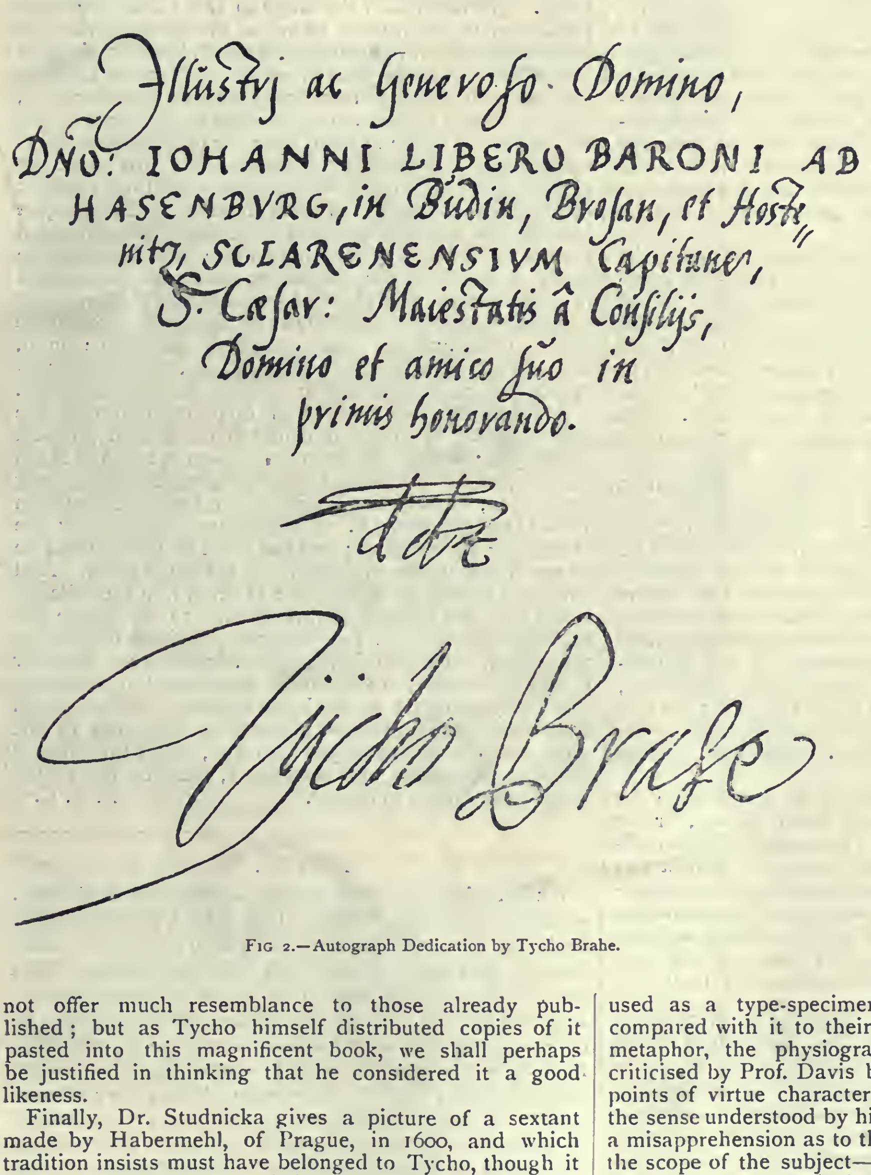
ON October 24, 1901, three hundred years will have elapsed since the death of Tycho Brahe, and this memoir has been published in order to draw attention to that day and at the same time to give some account of the very few relics existing at Prague of the great astronomer, who spent his last years there and whose tomb is in the Teinkirche in that city. Print and illustrations of this memoir are excellent, but we could have wished that the text had been fuller and that at least one of the relics had been discussed in some detail. Tycho Brahe's instruments seem to have been destroyed during the Thirty Years' War, and not one of those he used at Uraniburg has been preserved; his library was scattered, but his manuscript observations fortunately found their way back to Denmark after having been thoroughly utilised by Kepler. The relics at Prague are therefore very modest ones—a few books from his library and a few manuscripts of no great importance. In the library of the Bohemian National Museum there is an album which Tycho gave his eldest son in 1599; on the first page of it is a portrait of the astronomer, reproduced in the present memoir. It is the well-known engraving by Geyn, coloured by hand. The book contains an autograph dedication by Tycho and a picture of his family arms, both of which Dr. Studnicka gives in facsimile. In the University Library there is a more important MS., containing on twenty leaves a short text-book on trigonometry, dated 1591. This was published in 1886 in photolithographic facsimile by Dr. Studnicka, who is exceedingly irritated with the writer of this review for having ventured to say that "Tycho has written his name under the title of the MS., but the handwriting of the remainder does not seem to be his." He even insinuates that the writer had perhaps never seen the facsimile reprint when he uttered this shocking heresy. The fact is, that the excellent reprint showed that the MS. in question was written in an extremely legible and distinct hand, while Tycho's astronomical MSS. in Copenhagen are anything but pleasant to wade through, and we are still of the opinion that it is very doubtful (to say the least) whether the MS. in question was written by Tycho himself. But this is really of no consequence, as nobody doubts that he is the author of it. The University Library also possesses a MS. copy of the table of sines of Copernicus, written by Tycho. Of much greater interest is a copy of the edition of Ptolemy's works of 1551, on the title-page of which Tycho has written that he bought it at Copenhagen on November 30, 1560, for two thaler. He was barely fourteen years of age when he obtained this standard work, and he made good use of it, as appears from the great number of marginal notes which he entered in it from time to time. We should have liked very much to have learned something about these notes, which doubtless would throw much light on the growth of the owner's knowledge, but

FIG. 1.—Portrait of Tycho Brahe.

[1] "Prager Tychoniana." Gesammelt von Prof. Dr. F. I. Studnicka. 65 pp. 8vo, with a coloured frontispiece and illustrations in the text. (Prague, 1901.)

we are told nothing about the nature of the notes, nor about those written in a copy of the work of Copernicus (the Basle edition of 1566), which are also supposed to be in Tycho's hand.

One of the finest Tychoniana at Prague is a copy of the original edition of the "Astronomiæ Instauratæ Mechanica," printed (apparently in a small number of copies) in 1598. As in several other existing copies, the illustrations in this one have been coloured by hand, and there is a portrait inserted in it of which we are glad to be able to append a copy as well as a copy of the author's dedication to the Bohemian Baron von Hasenburg. As we have already remarked elsewhere ("Tycho Brahe," p. 263), this portrait does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SCLARENENSIVM Capitaneo,
S. Cæsar: Maiestatis à Consilijs,
Domino et amico suo in
primis honorando.

Tycho Brahe

FIG 2.—Autograph Dedication by Tycho Brahe.

not offer much resemblance to those already published; but as Tycho himself distributed copies of it pasted into this magnificent book, we shall perhaps be justified in thinking that he considered it a good likeness.

Finally, Dr. Studnicka gives a picture of a sextant made by Habermehl, of Prague, in 1600, and which tradition insists must have belonged to Tycho, though it has none of the characteristics of his own instruments. Though this memoir does not bring out any new facts, the numerous illustrations in it are very interesting, and it is a pleasant proof of the veneration in which the memory of the great astronomer is held in the country where he finished his career. J. L. E. D.

PHYSIOGRAPHY AND PHYSICAL GEOGRAPHY.

THE progress of science, and human perversity, are jointly responsible for remarkable variations undergone by scientific words and terms with the lapse of time. Natural science, which once comprised all knowledge obtained by experiment and observation, now, as many think, only signifies natural history; physical science includes chemistry; physical astronomy is no longer the astronomy of Kepler, but that of the telescope and spectroscope; and physical geography is gradually assuming the name of physiography without acquiring the breadth of view which characterises this science. An article by Prof. W. M. Davis in the *School Review*, published by the University of Chicago Press, brings this nominal metamorphosis prominently before us. Prof. Davis defines physical geography—or physiography—which he considers as synonymous, as "the study of those features of the earth which are involved in the relation of earth and man; that is, the study of man's physical environment." So far as physical geography is concerned, this statement of its boundary lines is satisfactory, but when Prof. Davis uses the definition as a touchstone to test the character of physiography as understood by the examiners for the Department of Science and Art, he employs a criterion having no logical basis whatever.

Though, unfortunately for precision of scientific expression, physiography is often taken to mean physical geography, especially in the United States, the two departments of knowledge ought to be distinctly recognised as separate and fundamentally different in scope. It is perhaps a little late in the day to insist upon the distinction, for a hybrid has been produced which has commendable features and gives hopes of fertility; but what we do object to is that the hybrid is being used as a type-specimen, and its parents are being compared with it to their own detriment. To drop the metaphor, the physiography of South Kensington is criticised by Prof. Davis because it does not possess the points of virtue characteristic of physical geography in the sense understood by him. As he appears to be under a misapprehension as to the original use of the word and the scope of the subject—an obliquity shared, moreover, by many other physical geographers—it may be worth while to recall the circumstances which led to its adoption.

Until the year 1877 the Department of Science and Art held examinations in physical geography as generally understood. The Education Department also held

examinations in physical geography. Grants in aid of teaching were made for successful candidates by each Department; but it was found that many pupil teachers presented themselves for examination by the Department of Science and Art after they had passed the examination of the Education Department, and they thus earned grants twice over for the same subject. To avoid this duplication, it was decided to limit physical geography to the Education Department, and to give the subject under the Department of Science and Art a wider scope and call it physiography. The subject was instituted in place of physical geography by a minute of the Lords of Committee of Council on Education dated August 15, 1876, and the first examination was held in the following year, the syllabus having been drawn up by Sir Norman Lockyer. The deliberate purpose was to introduce a subject which was not physical geography at all, and to prevent candidates with a knowledge of physical geography only from scoring a success upon their knowledge in the examinations in physiography. If this is remembered, the unreasonableness of criticising the physiography of the Department of Science and Art from the point of view of the physical geographer is at once obvious. There is nothing to justify the occupation of this position, and the comparison made from it has no significance.

The general impression is that Huxley first used the word physiography in the sense in which latter-day advocates of physical geography like to understand it. Prof. Davis commits himself to this opinion in the remark that "the term physiography has been adopted [by the South Kensington authorities] because of Huxley's use of it as a title for a series of lectures in 1869 and 1870." Now, as a matter of fact, this statement is not correct. The subject of the lectures was, as Huxley's disciples know, the Thames and its basin; and when the lectures were published eight years later, some elementary information was added on the movements of the earth and the constitution of the sun, and the title of "Physiography" was given to the book thus brought into existence. This Huxley clearly stated in the preface to his inspiring volume, and he also remarked "I borrowed the title of physiography," but that is usually overlooked. In the interval between the delivery of the lectures and their publication, physiography was adopted by the Department of Science and Art as a subject for examination, and what Huxley really did was to give his book the title of the new subject. The same title—physiography—was used by Prof. Ansted for a book published shortly before Huxley's work.

It therefore appears that there is no justification for fathering the term physiography upon Huxley, or for using the contents of his book "Physiography" as an affidavit testifying to the devolution which the subject has undergone on account of the South Kensington examinations. An acquaintance with the actual circumstances which caused the introduction of the subject and the adoption of its title by Huxley would have enabled Prof. Davis to see the matter in a little better light than that in which he wrote his criticism.

It is, however, not the object here merely to show the weak points of a criticism; that is, after all, a small matter in comparison with the meaning which should be attached to the word physiography. Etymologically considered, physiography is the science which is concerned with the facts and phenomena of the whole of nature, and therefore embraces all the natural and physical sciences. The separate sciences have had their fields of activity staked out, and work is continuously carried on in them; but the boundaries are only marked here and there, and it becomes more difficult to define them every day. The amalgamation of all these interests in a company which aims at increasing natural knowledge, represents in a way the relation between the separate sciences and physiography conceived in the widest spirit. Perhaps a philosopher will one day arise and produce from the discrete collections of scientific facts a structure in which all available material shall be fitted into its true place; and the monument thus erected should be called physiography. Or, using another simile, what is wanted is a Darwin who will trace the complete development of organic and inorganic sciences, and show the mutual relations between the stores of knowledge at present kept in different departments. The work in which this is done will be a work on physiography.

The complete co-ordination of scientific material can, however, only become possible when omniscience is reached; what the apostles of physiography have now to do is to preach the gospel of the study of all natural knowledge. He who limits the study to the causes and consequences of the various forms of the earth's surface is not concerned with physiography at all, but with physical geography. As was pointed out by Sir Norman Lockyer long ago, in passing from geography to physiography, we pass from γῆ to φυσις, from the earth to the universe, and unless that is borne in mind the view of physiography is restricted and unnatural. Considered in this light, the physiography of South Kensington examinations presents characteristics worthy of consideration. The subject includes the main fundamental principles of observational science, and the application of these principles to the study of the earth, the sun, moon, stars and other bodies in the universe. The physical environment of man is not considered as such, and though prominence is given to the earth's crust and the changes which take place in it, the point of view is largely physical, and physical causes rather than anthropomorphic consequences are included.

It will thus be seen that there is no pretence to make the physiography of South Kensington the field of physical geography, whether the latter expression is taken to mean the subject as conceived by the geographers of a former generation, or whether it is given the interpretation Prof. Davis puts upon it. It is of course open to any one to criticise the syllabus; but the point of view should be as much that of the physicist as of the geographer. And whatever is said, let it be borne in mind that the syllabus is the only one existing in this country to encourage the experimental study of the physical principles underlying astronomy, earth-knowledge, and meteorology. Whether it would be better, in view of the meaning attached to the word physiography in the United States, for the South Kensington examiners to discontinue their use of the term, and divide the subject into two, under the titles of physical geography and astronomy, must be left to the proper authorities to decide. R. A. G.

NOTES.

WE learn from the *Times* that on Saturday last Prof. Slaby, of the Charlottenburg Technical High School, gave an interesting lecture before the Emperor of Germany and a distinguished company upon improvements which his former assistant, Count Arco, and himself have made in the art of wireless telegraphy. It has not hitherto been possible to use wireless telegraphy for communicating with several different stations at the same time. Prof. Slaby has now succeeded in overcoming this difficulty, and on Saturday night he communicated from the conference room of the General Electric Company in Berlin with operators in the laboratory of the Technical High School at Charlottenburg and in the works of the General Electric Company at Ober Schönweide. These two stations are distant about two and eight miles respectively from the conference room in which the experiment was conducted. Prof. Slaby used two instruments, both of which were connected with a lightning conductor in the neighbourhood. One of the instruments was made to syntonise exactly with that in the laboratory at Charlottenburg, the other

with the instrument in the works at Ober Schönweide. The experiment was a great success, especially in view of the fact that the greater part of Berlin separated the conference room from one of the stations with which messages were exchanged. The German Emperor displayed the greatest interest in the experiments, and afterwards conversed for some time with Prof. Slaby and Count Arco.

WE much regret to announce that Lord Armstrong, F.R.S., died this morning (December 27), at his seat, Cragside, Rothbury, Northumberland.

LORD KELVIN, Master of the Clothworkers' Company, has accepted an invitation to dine with the governors of the Yorkshire College on February 1, on the occasion of their annual gathering at Leeds. He is expected to deliver an address on textile industries.

IN answer to Lady Warwick's appeal for a millionaire to continue and develop the work of her Women's Agricultural College at Reading, a wealthy gentleman has since come forward with an offer of 50,000*l*. for the hostel.

PROF. F. E. NIPHER, of Washington University, Saint Louis, Missouri, announces that, after many months of failure, he has succeeded in developing a fine reversed photographic picture with the developing bath fully exposed to direct sunlight. The operation lasted a full half-hour, with no trace of fog. The developer was a modification of the hydrochinone, the formula for which is given in every box of "Cramer" plates. The bromide was left out, and the sodium carbonate solution was made up at half the strength used for negatives. The mixed developer was diluted with water in the proportion of one part to nine.

MR. W. ERNEST COOKE, Government Astronomer of Western Australia, sends us an account of observations of November meteors, made by Mr. W. C. Best near Newcastle (W.A.), on November 10, at about 9.30 p.m. Mr. Best says:—"The meteors appeared to come from a north-easterly direction and went toward the north. They all seemed to come from one point and spread out as they travelled, each one leaving a streak of light to mark its course. From the point where they started to where they disappeared seemed about 5° or 6°. The display lasted about 30 secs., during which time I saw from 100 to 200 stars shoot."

MR. SOWERBY WALLIS, who was for nearly thirty years associated with the late Mr. G. J. Symons, F.R.S., and has since the latter's death carried on the British Rainfall Organisation, will, from the beginning of next year, be joined in the work by Dr. H. R. Mill, who has resigned the librarianship of the Royal Geographical Society for that purpose.

THE Paris correspondent of the *Chemist and Druggist* states that at the Paris Natural History Museum a laboratory has recently been opened for biological studies applied to the French colonies. The work of the new laboratory will be to reply to inquiries relating to biology, geology and mineralogy, and to prepare precise instructions for foreign correspondents regarding the rearing of animals and cultivation of plants in the respective countries.

OUR attention has been directed to the following surprising announcement, made by the Pekin correspondent of the *Times*: "In pursuance of their regrettable policy of appropriation, the French and German generals, with Count von Waldersee's approval, have removed from the wall of Pekin the superb astronomical instruments, erected two centuries ago by the Jesuit fathers. Half of them will go to Berlin and the rest to Paris. The explanation of this act of vandalism is that, inasmuch as the return of the Court is so improbable, such beautiful instruments should not be exposed to the possibilities of injury when Pekin is no longer the capital."

AN exhibition of photographs by Mr. F. M. Sutcliffe, of Whitby, will be opened on Wednesday next, January 2, in the rooms of the Royal Photographic Society. Admission can be obtained on the presentation of a visiting card.

A NEW meteorological observatory was opened at Aachen (Aix-la-Chapelle) in September last and placed under the superintendence of Dr. P. Polis. From all points of view this establishment is well fitted for carrying on, not only the usual climatological observations, but various researches in atmospherical physics. The last volume of the observations has just been published, for the year 1899, and contains the records for six subsidiary stations, in addition to the records of about thirty rainfall stations, and several valuable discussions, including one on the climate of Aachen. Observations were first commenced in the year 1838 by Dr. Heis, and since 1873 the observatory has formed one of the official stations of the German network. Dr. Polis is a constant contributor to meteorological science in various German periodicals, and we congratulate him upon the establishment of his new observatory and the means now at his disposal for increased usefulness.

THE recent attempts to disperse hail storms by the firing of cannon or mortars, and the suggestion that vortex rings projected by the explosion may be the actual cause which disturbs the storm-cloud, have led Dr. G. Vicentini and Dr. G. Pacher to carry out a series of experiments on the velocity of these so-called "gaseous projectiles." The general conclusions agree with those of Pernter and Trabert, according to which the velocity of these vortices is much smaller than was supposed in the earlier investigations, and this velocity gradually decreases in consequence of viscosity. The authors find that in experiments on a small scale, pistols with a conical barrel give the best results. Some interesting laboratory experiments are described in which a small smoke ring was projected against a target formed of a thin capillary liquid film stretched on a circular frame. The different effects observed, according to the energy of the vortex, include the following: (1) the film bulges out, but returns to its original position, the vortex being arrested; (2) the ring destroys the film and proceeds on its way with diminished velocity; (3) the film is destroyed and the vortex, including most of the smoke, is imprisoned in a bubble which soon falls to the ground; (4) the vortex is imprisoned in a bubble, but the film behind returns to its original position; (5) the bubble which imprisons the vortex remains attached to the film and slowly sinks; (6) the film is destroyed, but the bubble rebounds in the opposite direction to that in which the vortex was projected. These experiments and observations are described in the *Atti del R. Istituto Veneto*, lix. lx.

THE much debated doctrine of partition of energy among the molecules of a gas is once more attacked by Mr. Burbury in the *Philosophical Magazine* for December. The paper consists mainly of an examination of the proofs of the law of equal partition, based on the two alternative methods of Maxwell and Lord Rayleigh, and of Boltzmann respectively, and the conclusions enunciated by Mr. Burbury are as follows: (1) The law of equal partition of energy among the translation velocities is not proved by the Maxwell-Rayleigh method; (2) It is not proved by Boltzmann's method, because the fundamental assumption on which that method is based is not proved; (3) Subject to any proof that may be given hereafter of Boltzmann's assumption, which, however, Mr. Burbury thinks can be disproved, the law is not generally true in any sense whatever. When, however, the density is very small, the mean translational kinetic energies of two molecules of unequal mass will differ only by small quantities of the second order. The law may, therefore, be asserted for the limiting case of an infinitely rar gas.

THE results of a new investigation of the anomalous dispersion of cyanin have recently been published by Dr. C. E. Magnusson in No. 41 of the *Bulletin* of the University of Wisconsin. An attempt has been made to determine the refractive indices throughout the whole spectrum, including the region of the absorption bands, by four distinct methods: (*a*) Direct spectrometer readings in the visible spectrum using solid prisms, the slit being illuminated with monochromatic light produced by an auxiliary spectroscope; (*b*) photographic records of the deviation of a system of monochromatic rays from a Rowland concave grating illuminated by an iron arc; (*c*) a qualitative method, using crossed prisms, and recording the results photographically; (*d*) photographic records of the displacement of the fringes in the Michelson interferometer produced by thin films of cyanin, prepared by dipping plates of glass in alcoholic solutions. To obtain good prisms by Prof. Wood's method, Dr. Magnusson finds that the substance must be heated rapidly, the prism formed and cooled quickly, and at the right temperature; if too cool, the fused mass cannot be pressed between the plates of glass to the required thinness, and if too hot, bubbles make their appearance. The general accordance of the values obtained by the different methods employed results in a fairly accurate dispersion curve for cyanin from the extreme red well into the ultra-violet, and the work with the interferometer gives conclusive evidence of the continuity of the curve through the absorption band in the yellow. It was originally intended to test the Ketteler-Helmholtz dispersion formula for the ultra-violet and extreme red rays, where Pflüger's investigations showed discrepancies. In the case of the ultra-violet it was suggested that the discrepancy might be due to an absorption band, and Dr. Magnusson considers that he has demonstrated the existence of such a band. Until further extensive observations have been made, however, he does not consider a comparison of the new values with the formula likely to be of much service. The results are illustrated graphically, and numerous photographs are reproduced.

AT a meeting of the Anthropological Institute on December 11, Mr. J. W. Crowfoot read a paper on the Bektashis of Cappadocia. Scattered about Turkey in Asia and Persia are many peculiar religious sects, either professing heretical forms of Islam or purely pagan in character, and in both cases hated and persecuted by the orthodox. It has been supposed that the adherents to these sects represent the earliest known inhabitants of the land, and that their religious rites contain relics that go back far beyond the rise of either Mohammedanism or Christianity. With the object of testing this theory, Mr. Crowfoot visited last summer some villages close to the ancient Halys in the Eastern half of Asia minor, occupied by a sect called the Bektash or Kizilbash. Measurements and photographs were taken which corroborate the theory above stated, though evidence was also found of an influx of some more eastern element, driven westwards, probably, at the time of the great Mongol invasions. These people are nominally worshippers of Ali, but in reality the worship of "heroes," from whom they profess descent, plays the greatest *rôle* in their religion. In one village there was a sacred well strongly impregnated with sulphur, and the fumes of this were inhaled by a prophetess who lived there until she fell into an ecstatic condition, in which she used to give answers to the many inquirers who resorted there, either to learn the future or to be cured by the "hero." Other survivals of a similar character were described. Some native weapons from the south-west of Lake Tanganyika, lent by Dr. Felkin, were also exhibited and described at the same meeting.

DR. J. BEARD has sent us a copy of his paper on the morphological continuity of the germ-cells in *Raia batis*, which appeared in the *Anatomischer Anzeiger*, vol. xviii. nos. 20 and 21. Germ-cells appear to be unicellular organisms, passing one stage of their existence within a multicellular sterilised stock, the embryo, which is formed by one of them at a definite period.

MR. E. S. SHRUBSOLE, the curator of the newly-formed Natural History Department at the Crystal Palace, sends us an announcement of the ten "tableaux" of mounted animals he has prepared for exhibition. They are stated to include 15,000 specimens. We are not at present aware of the manner in which they are arranged, but if they are not grouped according to their place of origin, a grand opportunity of familiarising the public with the leading features in geographical distribution will have been thrown away.

WE have received a copy of a memoir by Dr. S. J. Hickson on the Alcyonaria and Hydrocorallinæ of the Cape of Good Hope, published by the Department of Agriculture of the Cape in the series entitled "Marine Investigations in South Africa." Four new species of Alcyonarians are described; but of more importance are certain new investigations the author has been enabled to make into the anatomy of the group, owing to the excellent state of preservation in which the collection was sent to England. As these investigations are not yet completed, the author has published only the systematic work.

RICKETTS in monkeys that have died in captivity forms the subject of a memoir by Signor A Monti, published in the *Memorie* of the Royal Institute of Lombardy (vol. xix., part 3). The author proposes to defer the discussion of the bearing of his observations on zoology to a future occasion; but he claims for them great importance in regard to certain human diseases. For one thing, they definitely controvert the theory advanced by M. Parrot that ricketts in the human species is due to hereditary syphilis.

PHYSIOLOGICAL and pathological heredity in man forms the subject of Dr. T. Oliver's introductory lecture to a course of clinical medicine delivered in the Royal Infirmary at Newcastle-on-Tyne on October 31, a copy of which we have received from the *Lancet* office. The lecturer takes as his example of heredity the modern racehorse, and states that while none but thoroughbreds have won the Derby, no gelding has ever been first past the winning post, and that in all high-class races mares are much less frequently successful than stallions, although it should be added that they are less frequently entered. In one part of his discourse, Dr. Oliver touches upon the question of "telegony," which, in spite of the Penycuick experiments, he appears to think may not be a myth.

FROM Mr. G. E. H. Barrett-Hamilton we have received copies of five papers, four of which deal with local variation in European species of mammals. With one exception (from the *Annals of Natural History*) these latter are taken from the *Proceedings* of the Zoological Society. The species dealt with are the mountain or variable hare, the wood-mouse, weasel, hedgehog, and dormice. Of the first of these no less than eighteen local races are recognised, several being described for the first time. In districts where it normally turns white in winter the weasel is regarded as subspecifically distinct from the form which remains brown at all seasons. The fifth paper received from Mr. Hamilton is from the *Ibis*, and deals with the birds observed by him in Kamschatka in 1896 and 1897. The most important paragraphs in this communication are those dealing with colour and migration.

THE greater portion of the December issue of the *Zoologist* is taken up with a discussion on conscious protective resemblance in animals. Mr. G. A. K. Marshall commences the discussion with criticisms on Mr. Distant's articles on mimicry which appeared some time ago in the same journal. First of all he expresses the opinion that the term "mimicry" should be

restricted to resemblances assumed for the purpose of attracting attention; resemblances for the purpose of concealment being denoted by the terms protective and aggressive resemblance. He then proceeds to inquire whether any of such resemblances can be rightly termed conscious, concluding that the only instance which affords anything like proof of consciousness is one narrated by Mr. E. Thompson concerning the actions of a fox. But even if this be a true instance, the fox is such an abnormally clever animal that the case does not affect other supposed examples; and it is concluded that "there are good grounds for opposing the suggestion that active mimicry is of any general occurrence in the animal kingdom." Prof. E. B. Poulton continues the discussion in the form of notes, in which he gives a general support to the views of Mr. Marshall. Incidentally he mentions that the posture usually given to the leaf-butterfly (Callima) is incorrect. Mr. Distant adds a few remarks in defence of his own views, stating that the questions at issue are largely matters of opinion.

WE have received the first part of a new work by Prof. Der Vries, of Amsterdam, entitled "Die Mutations Theorie." It deals with the origin of new species; and these the author considers to arise solely as the result of sudden sporting, or of discontinuous variation. He does not regard the ordinary variation usually to be observed amongst the individuals of any given race as contributing towards the evolution of new species, but looks upon them as the transient and easily reversible expression of altered circumstances of life. The latter part of the book is occupied with an account of his observations on the "mutations" exhibited by *Œnothera Lamarckiana*, and he claims to have secured a number of discontinuously produced forms which retain their character in successive generations, and which show no tendency towards reversal, nor to the production of forms intermediate between themselves and the parent stock. Even if one does not feel inclined to accept all the author's conclusions, and even if lurking doubts as to the actual purity of the original strain of his Œnothera obtrude themselves on the mind of the reader, the book is worth a perusal for the sake of the lucid manner with which the arguments and facts are brought forward, and (sometimes) constrained to give support to the views therein advocated. It would be, however, premature to discuss the theory as a whole until the completion of the book enables one to form a mature estimate of its real value.

THE November *Journal* of the Royal Horticultural Society provides students of botany and others interested in problems of evolution with plenty of material for thought. Among the subjects dealt with in papers are the evolution of plants illustrated by the cultivated nature of gardens, by Mr. R. I. Lynch; problems of heredity as a subject for horticultural investigation, by Mr. W. Bateson, F.R.S.; aquatic plants, by Prof. G. S. Boulger; protoplasm, the instrument of evolution among plants, by the Rev. G. Henslow, who also contributes several instructive papers on plant structure and growth; the strawberry and gooseberry mildews, by Mr. E. S. Salmon, and descriptions of new plants exhibited at the meetings of the Society. Every one concerned with the science or the art of gardening will find in the *Journal* much suggestive and interesting information.

As a handy compendium of biographical particulars referring to men and women whose names are known in the worlds of literature, art or science, or who are distinguished in other ways, "Who's Who?" now stands alone, for with the 1901 edition, which Messrs. A. and C. Black have just published, is incorporated "Men and Women of the Time." The annual is a good index to the works, recreations and careers of practically every one alive whose influence upon human progress is recognised. All the living Fellows of the Royal Society appear to be included among the biographies, as well as numerous members of other scientific societies. The information tabulated before the biographies includes lists of abbreviations, peculiarly-pronounced proper names, the names and addresses of the chief newspapers and magazines, pseudonyms and pen-names, Fellows of the Royal Society, names, addresses and conditions of admission to scientific and other learned societies, chairs and professors in the universities, university degrees, and other matters of general interest. In the abbreviations we notice "anat.," signifying anatomy or anatomical, and "bot." for botany; but it is not easy to understand why these should be given, while other conventional abridgments, such as "math." for mathematics, "astr." for astronomy, "mech." for mechanics, "mag." for magnetism or magazine, "phys." for physical, "soc." for society," and "phil." for philosophical, are not explained. Either "anat." and "bot." should be omitted or others in just as common use should be inserted. The principle which has led to the selection of other abbreviations is also not clear. We find A.K.C. signifying Associate of King's College, and K.C. for King's College; but we do not see A.R.C.S. for Associate of the Royal College of Science, or U.C. for University College. B. Eng. is given for Bachelor of Engineering, but B.E. is the form usually adopted. D.Sc. is given, but not Sc.D.; and M.I.M.E. (Member of the Institution of Mechanical Engineers) is also omitted, while fellowship of the unrecognised Society of Science and Art is dignified by F.S.Sc.A. In the next edition the professors in the universities of London and Birmingham ought to be added to the list of those occupying chairs in the older universities.

THE additions to the Zoological Society's Gardens during the past week include a Cuvier's Gazelle (*Gazella Cuvieri*) from Algeria, presented by Mr. B. T. Barneby; a Golden Eagle (*Aquila chrysaëtus*) from Scotland, presented by Mr. H. E. Bury; a Rose Hill Parrakeet (*Platycercus eximius*) from Australia, presented by Mrs. Stoughton; a Burmese Tortoise (*Testudo elongata*) from Burmah, presented by Captain A. Pam; a Slow Loris (*Nycticebus tardigradus*) from the Malay Peninsula, three Ring-tailed Coatis (*Nasua rufa*) from South America, a Maximilian Parrot (*Pionus maximiliana*) from Brazil, two Lettered Aracaris (*Pteroglossus inscriptus*) from Para, two Adelaide Parrakeets (*Platycercus adelaidae*), four Plumed Ground Doves (*Geophaps plumifera*) from Australia, two Common Cassowaries (*Casuarius galeatus*) from Ceram, an Ural Owl (*Syrnium uralensis*), a Passerine Owl (*Glaucidium passerinum*), European, five Chestnut-bellied Finches (*Munia rubro-nigra*), six Bungoma River Turtles (*Emyda granosa*), a Roofed Terrapin (*Kachuga tectum*) from India, two Leopard Tortoises (*Testudo pardalis*) from South Africa, a South Albemarle Tortoise (*Testudo vicina*) from South Albemarle Island, three Wrinkled Terrapins (*Chrysemys scripta rugosa*) from the West Indies, a Muhlenberg's Terrapin (*Clemmys muhlenbergi*) from North America, an European Pond Tortoise (*Emys orbicularis*), European, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JANUARY, 1901.

Jan. 2–3. Epoch of the January meteors (Radiant $230° + 53°$).
3. 9h. Venus in conjunction with Neptune. Venus $1° 10'$ N.
3. 11h. 7m. Minimum of Algol (β Persei).
5. 9h. 45m. to 10h. 50m. Moon occults 1 Cancri (mag. 5·9).
6. 6h. 36m. to 7h. 31m. Moon occults A^1 Cancri, (mag. 5·6).
6. 7h. 56m. Minimum of Algol (β Persei).
6. 13h. 48m. to 15h. 4m. Moon occults 60 Cancri, (mag. 5·7).
9. 4h. 45m. Minimum of Algol (β Persei).
15. 9h. Venus in conjunction with Jupiter. Venus $0° 22'$ N.

Jan. 15. Venus. Illuminated portion of disc = 0·902, Mars = 0·949.

17. 21h. Jupiter in conjunction with moon. Jupiter 2° 13′ S.

18. 2h. Venus in conjunction with moon. Venus 2° 12′ S.

18. 16h. Saturn in conjunction with moon. Saturn 2° 41′ S.

19. 18h. 37m. to 21h. 21m. Transit of Jupiter's Sat. III.

24. 8h. Venus in conjunction with Saturn. Venus 0° 20′ S.

28. 8h. 3m. to 8h. 28m. Moon occults 13 Tauri (mag. 5·4).

29. 6h. 0m. to 6h. 37m. Moon occults DM+20°, 785 (mag. 5·8).

30. 14h. 41m. to 15h. 36m. Moon occults χ^1 Orionis (mag. 4·7).

EPHEMERIS FOR OBSERVATIONS OF EROS.—The following is an abridgment of Herr Millosevich's ephemeris for January:—

Ephemeris for 12h. Berlin Mean Time.

1901.	R.A. h. m. s.	Decl. ° ′ ″	Mag.
Jan. 1	2 3 52·80	+37 55 14·5	
3	9 2·80	37 3 39·5	8·44
5	14 27·17	36 12 7·3	
7	20 4·92	35 20 39·0	8·45
9	25 55·21	34 29 15·8	
11	31 57·23	33 37 59·2	8·45
13	38 10·17	32 46 50·5	
15	44 33·19	31 55 51·2	8·46
17	51 5·61	31 5 3·0	
19	2 57 46·65	30 14 27·1	8·47
21	3 4 35·62	29 24 5·4	
23	11 31·79	28 33 59·3	8·49
25	18 34·34	27 44 10·1	
27	25 42·53	26 54 39·0	8·52
29	32 55·50	26 5 26·8	
31	3 40 12·48	+25 16 34·8	8·55

DIAMETER OF VENUS.—In the *Astronomische Nachrichten* (Bd. 154, No. 3676) Prof. T. J. J. See announces the results of a long series of measurements of the diameter of Venus, made with the filar-micrometer on the 26-inch refractor of the U.S. Naval Observatory at Washington. He also prefaces his remarks by a *résumé* of the observations of the diameter which have been made since the time of Galileo (1620).

The difficulties of the determination are summarised thus:—

(1) The enormous change in the geocentric distance of the planet renders the apparent diameter extremely variable.

(2) The thin line-like horns presented when the planet is near inferior conjunction are easily affected by atmospheric disturbances, rendering bisection with the micrometer wire difficult.

(3) As the crescent enlarges the diameter decreases.

(4) Near superior conjunction, although the disc is nearly round, its diameter is so small, and the time of observation is necessarily such that the heated atmosphere has a great disturbing effect on the definition.

(6) Irradiation, which is always great on account of the brilliancy of the planet.

Much of the difficulty due to the brilliancy has been eliminated by the use of coloured screens between the eye and telescope, as described in *A.N.* Nos. 3636, 3665.

The mean of Prof. See's determinations on 22 days gives a mean diameter of

$$16''·80^{\circ} \pm 0''·022$$

which is in close agreement with the value 16·820 deduced by Dr. Auwers in 1894 from the transits of Venus in 1874 and 1882.

Several suggestions are included comparing the work with heliometer and filar micrometer on planetary diameters, the two giving variable results with different planets.

REDUCTION OF OCCULTATIONS.—M. L. Cruls, director of the Observatory of Rio Janeiro, has published an improved method of time determination from lunar occultations, based on the exact knowledge of the instant of apparent conjunction of the two bodies. The formulæ of Bessel are slightly modified, and both analytical and graphical solutions given at length, with examples of each.

NATURAL AND ARTIFICIAL PERFUMES.

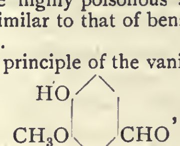
THE passing century has seen the rise and subsequent decay of several great branches of chemical industry. Early in the century, when the chemical methods applicable to the manufacture of alkalis and of alkali products were being actively developed, profits were large, whilst now that the chemical difficulties encountered in the manufacture of alkali have been practically overcome, the financial prosperity of an alkali works depends mainly upon economy in carrying out certain engineering processes; the science of the chemist is now of rather less importance than the art of the engineer. The younger industry of coal-tar dye-stuff manufacture is similarly, though more gradually, developing into a branch of engineering, and in consequence money is not made so rapidly as was once the case. During the last twenty-five years a new chemical industry, that concerned with artificial perfumes, has made rapid progress and would seem to give more promise of both chemical and financial prosperity than either of its elder sisters. Perfumes are only needed in small quantities, but, in accordance with the law that anything ministering to our pleasures fetches a far higher price than a mere article of utility, profits upon a really gigantic scale may be easily obtained; again, the enduring chemical prosperity of the new industry is assured in that a constant succession of new perfumes is absolutely necessary; by the time that improved methods of manufacture and competing processes have lowered the price of a perfume, the material has become unfashionable. No lady would use a cheap perfume. Further, the sense of smell in man is as yet wholly uncultured; in walking through the country we can rarely identify a particular odour caught until the sight of the plant from which it emanates makes us wonder at our hesitation. The coal-tar colour industry found us provided with a highly-developed system of colour perception, whilst the newly-inaugurated artificial perfume industry has to cultivate a neglected sense probably possessing similar artistic potentialities.

The scientific methods adopted in the new industry consist, in the main, of three: (1) in the extraction of odoriferous compounds from the natural products in which they occur; (2) in the artificial preparation of naturally occurring odoriferous compounds by synthetic processes; and (3) in the manufacture of materials possessing odours resembling those of naturally occurring substances of pleasant smell. The odoriferous principle of bitter almond oil was one of the first isolated and subsequently synthesised; the oil was obtained during the Middle Ages by distilling bitter almonds with water, whilst, nowadays, only very small quantities are prepared from the almond. Apricot kernels are first freed from fatty oils by hydraulic pressure, and then caused to undergo a fermentative process. The kernels contain a glucoside, amygdalin, which, at a suitable temperature, is hydrolysed by an unorganised ferment, emulsin, also present, with formation of benzaldehyde, $C_6H_5.CHO$, hydrogen cyanide and grape sugar, in accordance with the equation

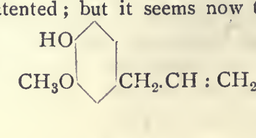
$$C_{20}H_{27}NO_{11} + 2H_2O = C_6H_5.CHO + 2C_6H_{12}O_6 + HCN.$$

The mass is then distilled in a current of steam, and the resulting oil separated from the aqueous distillate and freed from the prussic acid which it still retains. Liebig and Woehler first separated pure benzaldehyde from crude bitter almond oil in 1832. Benzaldehyde is prepared on a large scale by the hydrolysis and oxidation of benzyl chloride by boiling it with cupric or lead chloride solution; the artificial oil retains with great tenacity traces of benzyl chloride, and the penetrating, unpleasant odour of this impurity renders the product fit only for scenting common soaps and prevents its use in perfumery. Nitrobenzene, $C_6H_5.NO_2$, the highly poisonous so-called oil of mirbane, has an odour very similar to that of benzaldehyde, and is sometimes used in its place.

Vanillin, the odoriferous principle of the vanilla bean, is an aldehyde of the constitution

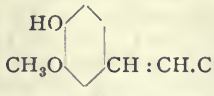


, and was artificially prepared in 1874 by Tiemann and Haarmann; the original method of preparation consisted in oxidising coniferin, a glucoside contained in the sap of various coniferæ, with chromic acid. Many different methods of preparing vanillin have been patented; but it seems now to be mainly obtained from eugenol,

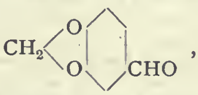


a phenol contained

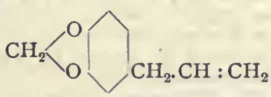
to the extent of 70 to 90 per cent. in oil of cloves; this is heated with alkali, which converts it into isoeugenol



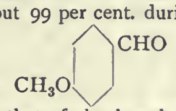
and the latter is then oxidised to vanillin. Synthetic vanillin has practically displaced the vanilla bean for use in perfumery and the manufacture of confectionery, and, in spite of frequent adulteration with sugar, acetanilide and other comparatively valueless materials, the price of the genuine synthetic article is now only a little more than 1 per cent. of that obtained in 1876. The nearly related aldehyde, piperonal,



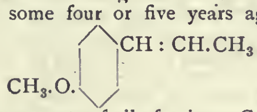
which has a very powerful odour resembling that of the heliotrope, and is consequently used in perfumery under the name of "heliotropin," is largely prepared from safrole



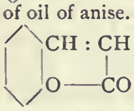
a methylenic ether contained in oil of sassafras and oil of camphor; its price has dropped by about 99 per cent. during the last twenty years. Anisic aldehyde,



which has an intense odour resembling that of the hawthorn flower, was greatly in use some four or five years ago; it is prepared from anethol,



the ether constituting 80 or 90 per cent. of oil of anise. Coumarin, orthohydroxycinnamic anhydride,



is the material to which the tonka bean, sweet woodruff and new-mown hay owe their characteristic odours; it was synthetically prepared by W. H. Perkin, sen., in 1868, by heating sodiosalicylic aldehyde with acetic anhydride, and was obtained commercially by this method until its recent discovery in considerable quantities in *Liatris odoratissima*, a herb indigenous to Florida, provided a cheaper method of preparation. The pleasant smell of cassia oil is due to its containing from 75 to 90 per cent. of cinnamic aldehyde, $C_6H_5.CH:CH.CHO$, which was first synthesised by Strecker; the aldehyde is readily obtained by condensing benzaldehyde with acetaldehyde in presence of soda; and has, indeed, been commercially obtained by this method at times when the Chinese cassia oil distillers adulterated the oil to too great an extent with petroleum, resin, &c.

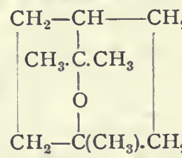
The greater number of the ethereal oils prized in perfumery owe their pleasant odours, not to one constituent alone, but to several, and the smell of the more valuable, such as lavender oil, rose oil, Ylang-Ylang, &c., is a blend of the odours of a number of odoriferous components; the determination of these constituents and their preparation in a state of purity with a view to an ultimate successful imitation of particular ethereal oils has long constituted one of the most intricate problems of industrial chemistry, one, however, which has been attacked with astonishing success. A few of the more important odoriferous principles may be briefly discussed. The aldehyde citral or geranial, $C(CH_3)_2:CH.CH_2.CH_2.C(CH_3):CH.CHO$, constitutes about 6 per cent. of oil of lemons and about 80 per cent. of lemongrass oil, and gives to these oils their lemon-like odour; it is largely prepared, commercially, from lemongrass oil, and is accompanied in nature by its dihydro-derivative, citronellal, $C(CH_3)_2:CH.CH_2.CH_2.CH(CH_3).CH_2.CHO$. Citral was synthesised from acetoacetic ether by Tiemann in 1898, and is converted by reduction into the alcohol, geraniol,

$$C(CH_3)_2:CH.CH_2.CH_2.C(CH_3):CH.CH_2.OH.$$

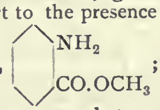
Similarly, citronellal yields on reduction the corresponding alcohol, citronellol,

$$C(CH_3)_2:CH.CH_2.CH_2.CH(CH_3).CH_2.CH_2.OH;$$

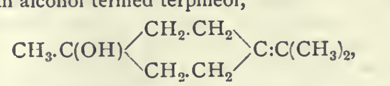
geraniol, further, can be converted into an isomeric alcohol, linalool, $C(CH_3)_2:CH.CH_2\,CH_2.C(CH_3)(OH).CH:CH_2$, by heating with water. These three alcohols, geraniol, citronellol and linalool, yield esters with acids, such, for example, as linalyl acetate, $C(CH_3)_2:CH.CH_2.CH_2.C(CH_3)\Big\langle{CH:CH_2 \atop O.CO.CH_3}$. These aldehydes and alcohols, together with a number of the esters formed with fatty acids, occur in many ethereal oils. French oil of lavender is distilled from wild lavender in the hills of southern France, and contains 30 to 40 per cent. of linalyl acetate and about an equal quantity of linalool and small quantities of geraniol; English oil of lavender is distilled from the cultivated plant, and contains only 5 to 10 per cent. of linalyl acetate, but considerable amounts of cineol,



The fact that English oil fetches about ten times the price of the best French oil is a frequent source of unfavourable comment by Continental merchants. Ylang-Ylang oil contains linalool and geraniol, and apparently also the acetic and benzoic esters of both alcohols; the similar, though less valuable, Cananga oil contains smaller quantities of the esters and larger quantities of a sesquiterpene, $C_{15}H_{24}$. Otto of roses, which has for centuries been the most highly prized of all perfume oils, is obtained in the East, in Bulgaria, Germany and, to a small extent, in France, by distilling freshly-gathered roses with water; it contains a wax-like hydrocarbon, the so-called stereoptene, and during the last month Walbaum and Stephan have shown that German rose oil owes its odour to geraniol, citral, citronellol, linalool, nonylic aldehyde, $C_9H_{19}.CHO$, and phenylethylic alcohol, $C_6H_5.CH_2.CH_2.OH$. It is interesting to note that Neroli oil, which contains linalool, geraniol and linalyl acetate, owes its odour in part to the presence of a small percentage of methyl anthranilate,

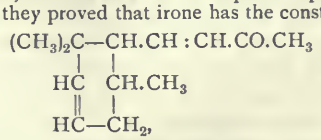


; this substance, in an undiluted condition, has a somewhat unpleasant odour, but when highly diluted smells very much like oil of bitter orange. An alcohol termed terpineol,



is found in many essential oils, and is readily and cheaply prepared by the action of dehydrating agents upon terpin hydrate, which in turn is easily prepared from turpentine oil; terpineol has a powerful odour of lilac, and consequently finds extensive application as a basis in the manufacture of perfumes.

Oil of orris, mainly obtained from Italian orris root, consists, to the extent of about 35 per cent., of the odourless myristic acid. In 1893 Tiemann and Krueger showed that the odour of fresh violets possessed by the oil is due to the presence of a small proportion of a ketone to which they gave the name irone; as the result of an important piece of experimental work, they proved that irone has the constitution

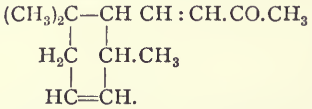


and a patent was obtained by Haarmann and Reimer for a method of separating this ketone from oil of orris. Tiemann and Krueger, before actually ascertaining the constitution of irone, conceiving the possibility of preparing a substance of the same molecular composition as irone from citral, endeavoured to do so in order to obtain information as to the constitution of the ketone. They found that, on allowing a mixture of citral and acetone to remain in contact with baryta solution, an

ordinary acetone condensation slowly occurs with formation of a ketone, the so-called pseudoionone, having the constitution

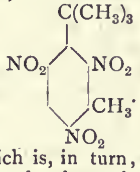
$CH(CH_3)_2.CH_2.CH:CH.C(CH_3):CH.CH:CH.CO.CH_3$.

Pseudoionone has a peculiar but not very pronounced smell, and, when heated with a mixture of water, glycerol and sulphuric acid, undergoes conversion into an isomeric ketone, termed ionone, which possesses the constitution



Ionone possesses an odour of fresh violets, which also feebly recalls that of grape blossom; it is manufactured on a large scale for use in the preparation of violet perfumes. The preparation of homologues of ionone from citral and methylethylketone has also been protected, and numerous attempts to evade the original patents have naturally been made; the use of lemongrass oil in place of citral, and of bleaching powder as a condensing agent in place of baryta, have been patented, but these patents have not been upheld by the Courts. It is a very remarkable fact that the two ketones, irone and ionone, possess odours so similar that, either when pure or diluted with alcohol, a trained nose is only just able to distinguish between them. The similarity in odour is doubtless due to the almost identical type of molecular grouping contained in the two compounds. Oil of turpentine consists essentially of a hydrocarbon of similar molecular type to irone and ionone, and it is a very noteworthy fact that turpentine, when administered internally, imparts a strong odour of violets to the urine; so far as can be ascertained, this fact has received no commercial application.

A number of substances have been introduced into commerce as substitutes for musk; of these, the first was the trinitroisobutyltoluene of the constitution



It is obtained by nitrating isobutyltoluene, which is, in turn, prepared by the interaction of isobutyl chloride and toluene brought about by aluminium chloride. This and other trinitro-derivatives of benzenoid hydrocarbons containing two alkyl groups in the meta-position possess a powerful odour of musk, and have been used to a considerable extent in perfumery.

The investigation and manufacture of artificial and synthetic perfume materials have been only carried on to a very small extent in this country; the new industry is almost wholly of German origin. During recent years, however, France appears to have been making great strides in synthetic perfume manufacture, and at the Paris exhibition this branch of chemical manufacture seems to be the only one in which the French exhibits equal, or even excel, those of Germany. The cause of this is obscure, but may possibly be connected with the generally recognised principle that supremacy in any particular industry goes hand in hand with supremacy in the related sciences; and all students of contemporary chemical literature will agree that in Germany the science of chemistry has been in rapid decadence during recent years. A good organisation, administered by a master, accomplishes great results; but when the directing hand is gone, the very organisation itself is found to have stultified the faculty for independent thought on the part of those originally destined by nature to take the lead. Subsequently the system aids only in the filling up of immaterial details, and the pioneer work is transferred to men from quite a different school.

Little has yet been accomplished towards ascertaining the relation between the odour and the chemical constitution of substances in general. Hydrocarbons as a class possess considerable similarity in odour, so also do the organic sulphides and, to a much smaller extent, the ketones. The subject waits for some one to correlate its various physiological, psychological and physical aspects in the same way that Helmholtz did for sound. It seems, as yet, impossible to assign any probable reason to the fact that many substances have a pleasant odour. It may, however, be worth suggesting that certain compounds, such as the volatile sulphides and the indoles, have very unpleasant odours because they are normal constituents of mammalian excreta and of putrefied animal products; the repulsive odours may be simply necessary results of evolutionary processes. W. J. P.

PRIZE LIST OF THE ACADEMY OF SCIENCES.

AT the annual public meeting of the Paris Academy of Sciences, on December 17, after the Presidential Address of M. Maurice Lévy, in which was a short account of the life work of MM. Milne-Edwards, Bertrand, Blanchard and Grimaux, the list of awards for the year 1900 was given.

In Geometry, the Grand Prize of the Mathematical Sciences was awarded to M. Mathias Lerch for work on the number of certain classes of quadratic forms; the Francœur Prize to M. Edmond Maillet, and the Poncelet Prize to M. Léon Lecornu. No memoir was received complying with the terms of the Bordin Prize. In Mechanics, the Extraordinary Prize of 6000 francs was divided between MM. Laubeuf, Charbonnier, Aubusson de Cavarlay and Grasset, M. Lerosey receiving the Montyon Prize, and Mme. Moissenet the Plumey Prize as a mark of esteem for the work done by her late husband.

In Astronomy, the Lalande Prize was adjudged to M. Giacobini for his work on comets; the Damoiseau Prize to M. J. von Hepperger for his work on the influence of the planets upon comets: the Valz Prize to M. l'Abbé Verschaffel for work done at the Abbadia Observatory; the Janssen Prize to Prof. Barnard for his brilliant discovery of the fifth satellite of Jupiter.

In Statistics, the Montyon Prize has been awarded to M. du Maroussem, the works of M. Barras, M. Laussedat and M. Pailhas receiving honourable mention.

In Chemistry, M. Béhal receives the Jecker Prize, and in Botany, M. H. Bruchmann the Desmazières Prize, M. Gyula Istvanfi having a very honourable mention. The Montagne Prize is divided between MM. Delacroix and Boistel. In Anatomy and Zoology the Thore Prize is awarded to M. Seurat for his researches on the parasitical larvæ of the Hymenoptera, and the Da Gamo Machado Prize to Mme. la Comtesse de Linden, M. Siedlecki, M. P. Carnot and M. Bordas, the Savigny Prize not being awarded.

In Medicine and Surgery, Montyon Prizes are adjudged to MM. Hallopeau and Leredde, for their treatise on dermatology; M. Guilleminot, for his work on the medical applications of the X-rays; and M. Joules Soury, for his book on the central nervous system. In connection with these prizes, mentions are accorded to M. Nobécourt, for his work on the pathogeny of the gastro-intestinal diseases of young children; M. Sabrazès, for his work on the origin of blood corpuscles; and M. Gallois, for a book on scrofula and odenoidal diseases; MM. Cunéo and Toulouse receiving citations. The Barbier Prize is divided between M. Marage, for a memoir on the theory of vowel formation, and M. Guinard, for a pharmacodynamic study of morphine and apomorphine, a mention being accorded to MM. Bræmer and Suis. In default of the discovery of an absolute specific for cholera, the arrears of interest on the Bréant Prize are divided between M. Auclair, for researches on the toxic substances contained in tubercle bacilli, and M. Paul Remlinger, for a memoir on some rare complications of dysentery, and the association of dysentery with typhoid fever. The Godard Prize is given to M. Léon Bernard, for his researches on the functions of the kidney in chronic nephritis; the Parkin Prize to M. Henri Coupin, for work done in plant physiology; the Dusgate Prize to M. Icard, for methods of diagnosis of real and apparent death; the Baron Larrey Prize to MM. Nimier and Laval, for three works on projectiles and explosives; the Bellion Prize being divided between M. J. Brault, for his treatise on tropical diseases, and M. Samuel Gache, for his treatise on workmen's dwellings in Buenos Ayres; the Lallemand Prize between M. Maurice de Fleury, for various treatises on medicine, and M. de Vabias, for his researches on the nervous system of aquatic gasteropods. Honourable mentions are accorded to MM. Knopf, Jacquet and M. Finck.

In Physiology the Montyon Prize is divided between M. Pachon for studies on cardiac and vascular mechanism and Mdlle. Jotéyko for memoirs on nervous effort and fatigue, and the Philipeaux Prize between M. Delezenne for his reseaches on anti-coagulating substances and M. Nicloux for experimental researches on the elimination of alcohol in the organism, M. Roussy receiving honourable mention; the Pourat Prize is awarded to MM. Bergonié and Sigalas for a determination of the principal anthropometric data; and the Martin-Damourette Prize to M. Long for his studies on the central paths of general sensibility. In Physical Geography, M. Lugeon receives the Gay Prize for his theory on the origin of Alpine valleys.

Among the General Prizes, a Montyon Prize is awarded to

M. Trillat for his applications of formaldehyde to industry, and to MM. Sévène and Cohen for their use of phosphorus sesquisulphide in the manufacture of matches in the place of ordinary phosphorus; the Cuvier Prize to M. Antoine Fritsch for his treatises on European Birds and on Palæontology, the Wilde Prize to M. Delépine, for his experimental researches on aldehydes; the Vaillant to M. Henri Gautier, for his work on alloys and on the atomic weight of boron; and to M. F. Osmond, for his researches on iron and steel; the Frémont Prize to M. Ch. Frémont, for his results on the testing of the resistance of metals; the Gegner Prize to Mme. Curie; the Delalande-Guérineau Prize to M. Maurain and M. Lacombe, for their work on the measurement of an arc of meridian at Quito; the Jérome Ponti Prize to MM. P. Girod and Massénat; the Tchihatchef Prize to M. de Loczy, for work on the Physical Geography and Geology of Eastern China; the Houllevigne Prize to M. Wallerant, for his researches in Crystallography. The Boileau Prize is divided between M. Sautréaux, M. Delemer and M. Nau; the Cahours Prize between M. Mouneyrat, M. Metzner and M. Defacqz.

The Saintour Prize is awarded to M. Debureaux, the prize founded by the Marquise De Laplace to M. Macaux, and the prize founded by M. Félix Rivot to MM. Macaux, de Schlumberger, Martinet and Hardel.

UNITED STATES GEOLOGICAL SURVEY.

THE work of the Geological Survey of the United States comes before us in almost overwhelming amount, and yet, as we take note of the publications, we have no sentiment but that of admiration for the evidence they give of brilliant, useful and painstaking research: research, too, of very varied character.

Bulletins.

A dozen numbers of the *Bulletin*, dated 1898 and 1899, have all been received since midsummer of this year.

Nos. 156 and 162 on the Bibliography of North American Geology for 1897 and 1898, contain the titles with, in many cases, brief notes of the contents of all geological publications dealing with the United States and Canada. Seven hundred and forty-two articles are recorded for 1897, and 941 for 1898. Here, indeed, is the index to a vast amount of information, which to be made available for general reference requires, ultimately, to be tabulated and summarised under many subjects.

Bulletin No. 154 is "A Gazetteer of Kansas," containing a list of all hamlets, post villages and townships, with, as far as possible, notes of their area, population and altitude; the whole prefaced with general statistics. No. 160 is the third edition of "A Dictionary of Altitudes in the United States," a work of 775 pages, arranged alphabetically, according to the localities in the several States. In Nos. 155 and 161 we find records of the earthquakes which happened in California in 1896, 1897 and 1898. A scale, divided into ten numbers, is given for estimating the intensity of shocks Thus No. vi. notes "general awakening of sleepers; general ringing of bells; swinging of chandeliers; stopping of clocks; visible swaying of trees; some nervous persons run out of buildings; window glass broken"; while No. x. tells of "Great disasters; overturning of rocks; fissures in the surface of the ground; mountain slides."

We pass on to other Bulletins, and in No. 152 have "A Catalogue of the Cretaceous and Tertiary Plants of North America," by Mr. F. H. Knowlton; and in No. 152, "A Bibliographic Index of North American Carboniferous Invertebrates," by Mr. Stuart Weller. These works must prove of the greatest value for reference. They are clearly printed, the synonyms are recorded, and there are lists of works on the subjects dealt with.

Other numbers of the Bulletin are of a different character. In No. 151 we have an account of "The Lower Cretaceous Gryphæas of the Texas Region," by Messrs. R. T. Hill and T. W. Vaughan. Fossil oysters have always been regarded as a troublesome and variable group, mainly, as the authors believe, because they have not been properly understood and classified. These fossils are, however, important, not merely from a zoological, but from a stratigraphical point of view, as shown by certain deep borings for artesian water in Texas. Abundant material is to be found in that country for their study. They lie strewn upon the surface in such numbers that they are sometimes used for road material or collected and burned into lime. Extensive masses of indurated strata are composed of them. The pebbles in the streams are largely made up of oysters. They represent many genera and species, and are of all sizes, from individuals less than an inch in length to shells which weigh 5 lbs. and more. They are found at various horizons throughout 4000 and more feet of rocks constituting the Cretaceous system in Texas. There is thus ample material for a study of the fossils from a phylogenetic and morphologic standpoint, and the authors here give their special attention to the Gryphæas. The work is admirably illustrated, and it is not obscured in any way by the indiscriminate naming of specimens.

No. 157, on "The Gneisses, Gabbro-schists and Associated Rocks of South-western Minnesota," by Mr. C. W. Hall, No. 158, on "The Moraines of South-eastern South Dakota," by Mr. J. E. Todd, and No. 159, on "The Geology of Eastern Berkshire County, Massachusetts," by B. K. Emerson, are all well illustrated, full of information of local importance and of much that is of general interest.

Indiana Report.

The geology and natural resources of Indiana are treated of by Mr. W. S. Blatchley, the State geologist, in the twenty-fourth annual report of the department (1899). The volume is one of 1078 pages, and is largely occupied with a catalogue, by Mr. S. Coulter, of the flowering plants and of the ferns and their allies indigenous to Indiana. A considerable portion is also taken by a descriptive and illustrated catalogue of the mollusca of the State, by Mr. R. E. Call. These include a large number of *Unios*. The dragon flies of Indiana are enumerated and described by Mr. E. B. Williamson, and there are notes on the batrachians and reptiles of Vigo county, by Mr. W. S. Blatchley. The economic resources of Indiana include coal, petroleum, natural gas, stone and clays. The amount of natural gas is restricted, and a failure of supply is expected. A great increase of activity in the coal regions is noted. There is estimated to be forty billions of tons of coal in Indiana, of which one-fifth is reckoned as workable under present conditions. Excellent coal for steam and household purposes and for blast-furnaces is obtained. Dr. A F. Foerste contributes an article on the Middle Silurian rocks of the Cincinnati anticlinal.

U.S. Annual Reports.

Parts i., iv. and vi., and portions of Part ii. of the nineteenth annual report were noticed in NATURE for April 19. We have since received Parts ii., iii. and v., four volumes, including an atlas. Part ii., which comprises 958 pages and 172 plates, is somewhat heavy and unwieldy as a work of reference. Of articles not previously noticed, one by Mr. C. W. Hayes deals with the physiography of the Chattanooga district in Tennessee, Georgia and Alabama. The city of Chattanooga lies almost in the centre of this district, and the term physiography is used in a purely geographical sense. The article is an essay on denudation, written according to the principles of modern geography. The author deals with the formation of three successive peneplains, and shows how the drainage has been modified and diverted until the present topographic features were developed. The peneplains are considered as the product of subaërial erosion. The term geomorphology is used for the description, classification and correlation of the land forms; and geomorphogeny for the natural processes by which these forms have been developed. The author gives definitions of other physiographic terms, which are being introduced at a somewhat alarming rate.

Another article in Part ii. is on the Geology of the Richmond Basin, Virginia, by Messrs. N. S. Shaler and J. B. Woodworth. The area is important from an economic point of view as it contains the only free-burning coal immediately adjacent to tidewater in the eastern portion of the United States. The strata are of Jura-Trias age, the fossils from the lower portion of them being more closely related to the Rhætic deposits of Europe than to those of any other horizon. The beds are grouped as the Newark formation, and they rest locally on a surface of igneous and crystalline rocks. Natural coke occurs in the strata, and is due to the intrusion of igneous rocks; it is denser than artificial coke. The bituminous coals are sharply parted from the cokes as the effects produced by the igneous rocks end abruptly. Mr. F. H. Knowlton contributes some notes on fossil coniferous wood from the Richmond Basin.

In Part v. the subject of Forest Reserves is elaborately dealt with by Mr. Henry Gannet and others. An endeavour is made to estimate the present amount of woodland distributed in the different States. Texas has the largest area, of about 64,000 square miles, while Arkansas has the largest percentage of woodland. The question of the protection of forests is one that is engaging much attention, so that the statistics and general information here brought together must be of great value. The report is illustrated by an atlas.

Of the Twentieth Annual Report we have received Part i. and Part vi. (2 vols.). Part i. contains the report of the Director, Mr. Charles D. Walcott, an admirable record of systematic work, which evidently receives the sympathy and substantial support of Congress. The appendix contains details of triangulation and spirit-levelling, and the work is accompanied by maps showing the progress of the surveys. Part vi. is on the Mineral Resources for 1898, the subject being under the direction of Mr. David T. Day. The total value of the mineral productions is the largest ever recorded in the history of the United States. All the metals, except nickel, made large gains, copper, lead, zinc, aluminium and antimony reaching their maximum, both in production and value. The amount of pig-iron produced was greater than in any other year, but the value was less. The non-metallic products also show an increase, especially bituminous coal, and in a lesser degree stone, petroleum and natural gas. The coal product amounted to about two hundred millions of tons.

Monographs.

Monograph No. 32, Part ii., is a large and handsome volume on the Geology of the Yellowstone National Park, by Mr. Arnold Hague and numerous colleagues. It opens with an account, by Messrs. J. P. Iddings and W. H. Weed, of the Gallatin Mountains, which consist of sedimentary strata ranging from Cambrian to Carboniferous, Jura-Trias, and Cretaceous (Laramie). Disturbances at the close of the Laramie formation were accompanied by igneous intrusions in the form of large laccolites, mainly andesitic in character. Electric Peak and Sepulchre Mountain are described as parts of a Tertiary volcano which was faulted across the conduit, the amount of vertical displacement having been more than 5000 feet.

Mr. Hague describes a mountainous area in the southern part of the Park, comprising ridges formed partly of Palæozoic but chiefly of Cretaceous rocks. The irregular outline of the mountains is due to the rhyolites of the Park Plateau that abut against the slopes of the upturned sedimentary strata. The Snake River hot springs are situated near the contact of the rhyolite with the Madison (Carboniferous) limestone, whence the travertine of the springs is derived. Mr. Iddings gives a particular account of the Miocene volcano of Crandall Basin, which arose on a ridge of Palæozoic rocks and on remnants of Eocene breccias and lava flows. The volcano consisted of andesitic breccias capped by basalt flows and traversed by dykes. It must have risen 13,400 feet above the limestone floor. The igneous rocks of the Absaroka range, and others which lie within Yellowstone Park, are specially dealt with by Mr. Iddings. The Cambrian fossils are described by Mr. C. D. Walcott, the Devonian and Carboniferous by Mr. G. H. Girty, the Mesozoic by Mr. T. W. Stanton, and the Fossil Flora (Laramie and Tertiary) by Mr. F. H. Knowlton.

Monograph No. 33 contains an account of the geology of the Narragansett Basin, a tract which includes Providence on the north and Newport on the south, being parts of Rhode Island and Massachusetts. The section on general geology is contributed by Mr. N. S. Shaler, while the detailed accounts are furnished by Mr. J. B. Woodworth and Dr. A. F. Foerste. Mr. Shaler remarks that the region originally contained an extensively developed series of pre-Cambrian rocks, which "may for convenience be referred to that limbo of ill-discriminated formations, the Upper Archæan (of Dana), or Algonkian." On these lie remnants of the Olenellus-beds of the Lower Cambrian, and above these are granites which have broken through the Cambrian, and have in turn been much eroded. On top lie the Carboniferous strata, which occupy the greater part of the basin and attain a thickness of several thousand feet. The general proposition is that this and other basins which lie along the Atlantic coast from Newfoundland to North Carolina are old river valleys which have been depressed below the sea-level, filled with sediments—the sedimentation increasing the depth of the depression—and afterwards corrugated by the mountain-building forces. The memoir is well illustrated with maps, sections and pictorial plates.

Monograph No. 34 is on the glacial gravels of Maine and their associated deposits, by Mr. George H. Stone. The subject is treated with a wealth of letterpress (499 pages) and illustrations. It is essentially a local memoir, but as the result of careful observations commenced so long ago as 1876, it is a most valuable record of facts on water-assorted glacial drift, useful to those studying glacial features, terraces, eskers and the probable effects of subglacial and englacial streams.

In Monograph No. 36 the Crystal Falls iron-bearing district of Michigan is described by Messrs. J. Morgan Clements and H. Ll. Smyth. This is the third of a series of reports on the iron-bearing districts of Lake Superior. The iron-ore (hæmatite and limonite) occurs in the Upper Huronian series. It is associated with white and reddish chert, and lies between carbonaceous slates in synclinal troughs. The memoir, however, deals with the structure, stratigraphy and physiography of a large area, approximately 540 square miles, and not only with Archæan and Huronian, but more particularly with various volcanic and intrusive rocks, microscopic sections of which form a main feature in the illustrations. A general introduction is written by Mr. C. R. Van Hise, and a final chapter on the Sturgeon River tongue in the south-eastern part of the district is by Mr. W. S. Bayley.

Monograph No. 37 is on the Fossil Flora of the Lower Coal-measures of Missouri, by Mr. David White, and is illustrated by seventy-two plates of Carboniferous plants, and one of a coal-seam.

Monograph No. 38, a large volume of 817 pages, numerous maps and other illustrations, is given up to a description of the Illinois Glacial Lobe, by Mr. Frank Leverett. This ice-tract formed the south-western part of the great ice-field that formerly extended from the high lands east and south of Hudson Bay over the basins of the Great Lakes and the north-central States as far as the Mississippi Valley. It overlapped a previously glaciated region on the south-west, whose drift was derived from ice which moved southward from the central portion of Canada. The evidence for separating the drift of the Illinois glacial lobe from the outlying and underlying drift is briefly stated. Remarkable instances of the transportation of limestone ledges are noted. These ledges in some instances occupy an area of several acres. They have been moved westward from the crest of rock ridges without completely destroying their stratification. Descriptions are given of well-defined soils and weathered zones which occur between successive accumulations of drift; various moraines and associated sheets of till are described, and there is a general discussion on the influence of the drift on drainage systems. The thickness of the Illinois drift is estimated at from 100 to 130 feet, and its bearing on water-supply is fully considered. Reference is made to gas-wells. In some the gas appears to be derived from the decay of vegetable matter in the drift; in most cases, however, it is probable that the underlying rocks contribute the gas, which is pent up beneath compact drift beds. A final chapter treats of soils, and these are classified into residuary soils, boulder-clay soils, gravelly, sandy and bluff-loess soils, silts slowly pervious to water, fine silts nearly impervious, and peaty or organic soils. The residuary soils show variations which correspond in a rude way with variations in the structure of the rocks, whether shale, limestone or sandstone, from which they are derived.

ON THE RELATIONS OF RADIATION TO TEMPERATURE.[1]

THE key to this subject is the principle, arrived at independently by Balfour Stewart and Kirchhoff about the year 1857, that the constitution and intensity of the steady radiation in an enclosure is determined by the temperature of the surrounding bodies, and involves no other element. It was pointed out by Stewart[2] that if the enclosure contains a radiating and absorbing body which is put in motion, the temperature being uniform throughout, then the constitutions of the radiation in front of it and behind it will differ on account of the Doppler effect, so that there will be a chance of gaining mechanical work in the restoration of a uniform state. There must thus be some kind of thermodynamic compensation, which might arise from æthereal friction, or from work required to

1 A paper read by Dr. J. Larmor, F.R.S., before Section A of the British Association at Bradford, September, 1900.

2 *Brit. Assoc. Report*, 1871; *cf.* also *Encyc. Brit.*, art. "Radiation" (1886), by Tait.

produce the motion of the body against pressure excited by the surrounding radiation. The hypothesis of friction is now out of court in ultimate molecular physics; while the thermodynamic bearing of a pressure produced by radiation has been developed by Bartoli and Boltzmann (1884), and that of the Doppler effect by Wien (1893).

Application of the Doppler Principle.—The procedure of Wien amounts to isolating a region of radiation within a perfectly reflecting enclosure, and estimating the average shortening of the constituent wave-lengths produced by a very slow shrinkage of its volume. The argument is, however, much simplified if the enclosure is taken to be spherical and to remain so; for it may then be easily shown that each individual undulation is shortened in the same ratio as is the radius of the enclosure, so that the undulatory content remains similar to itself, with uniformly shortened wave-lengths, whether it is uniformly distributed as regards direction or not, and whatever its constitution may be. But if there is a very small piece of a material radiator in the enclosure, the radiation initially inside will have been reduced by its radiating and absorbing action to that corresponding to its temperature. In that case the shrinkage must retain it always, at each stage of its transformation, in the constitution corresponding to some temperature. Otherwise differences of temperature would be effectively established between the various constituents of the radiation in the enclosure; these could be permanent in the absence of material bodies; but if the latter are present this would involve degradation of their energy, for which there is here no room, because, on the principles of Stewart and Kirchhoff, the state corresponding to given energy and volume and temperature is determinate. Thus we infer that if the wave-lengths of the steady radiation corresponding to any one temperature are all altered in the same ratio, we obtain a distribution which corresponds to some other temperature in every respect except absolute intensities.

Direct Transformation of Mechanical Energy into Radiation.[1]—There is one point, however, that rewards examination. When undulations of any kind are reflected from an advancing wall, there is slightly more energy in the reflected beam than there was in the incident beam, although its length is shorter on account of the Doppler effect. This requires that the undulations must oppose a resistance to the advancing wall, and that the mechanical work required to push on the wall is directly transformed into undulatory energy. In fact, let us consider the mechanism of the reflexion. Suppose the displacement in a directly incident wave-train, with velocity of propagation c, to be $\xi = a \cos (mx - mct)$; that in the reflected train will be $\xi' = a' \cos (m'x + m'ct)$, where a', m' are determined by the condition that the total displacement is annulled at the advancing reflector, because no disturbance penetrates beyond it; therefore, when $x = vt$, where v is its velocity, $\xi + \xi' = 0$. Thus we must have $a' = -a$, and $m' = m\,\dfrac{c-v}{c+v}$, in agreement with the usual statement of the Doppler effect when v is small compared with c. Observe, in fact, that the direct and reflected wave-trains have a system of nodes which travel with velocity v, and that the moving reflector coincides with one of them. Now the velocities $d\xi/dt$ and $d\xi'/dt$ in these two trains are not equal. Their mean squares, on which the kinetic energy per unit length depends, are as m^2 to m'^2. The potential energies per unit length depend on the means of $(d\xi/dx)^2$ and $(d\xi'/dx)^2$, and are of course in the same ratio. Thus the energies per unit length in the direct and reflected trains are as m^2 to m'^2, while the lengths of the trains are as m' to m; hence their total energies are as m to m'; in other words, the reflected train has received an accretion of energy equal to $1 - m'/m$ of the incident energy, which can only have come from mechanical work spent in pushing on the reflector with its velocity v. The opposing pressure is thus in numerical magnitude the fraction $\left(1 - \dfrac{m'}{m}\right)\dfrac{c}{v}$ of the density of the incident energy, which works out to be $\dfrac{c^2 - v^2}{c^2 + v^2}$ of the intensity of the total undulatory energy, direct and reflected, that is in front of the reflector.

When v is small compared with c, this agrees with Maxwell's law for the pressure of radiation. This case is also theoretically interesting, because in the application to æther-waves ξ is the displacement of the æther elements whose velocity $d\xi/dt$ represents the magnetic force; so that here we have an actual case in which this vector ξ, hitherto introduced only in the theoretical dynamics of electron-theory, is essential to a bare statement of the facts. Another remark here arises. It has been held that a beam of light is an irreversible agent, because the radiant pressure at the front of the beam has nothing to work against, and its work is therefore degraded. But suppose it had a reflector moving with its own velocity c to work against; our result shows that the pressure vanishes and no work is done. Thus that objection to the thermodynamic treatment of a single ray is not well founded.

This generalisation of the theory of radiant pressure to all kinds of undulatory motion is based on the conservation of the energy. It remains to consider the mechanical origin of the pressure. In the special case of an unlimited stretched cord carrying transverse waves the advancing reflector may be a lamina, through a small hole in which the cord passes without friction: the cord is straight on one side of the lamina, and inclined on the other side on account of the vibration; and it is easily shown that the resultant of the tensions on the two sides provides a force acting on the lamina which, when averaged, agrees with the general formula. In the case of an extended medium with advancing transverse waves, which are reflected directly, the origin of the pressure is not so obvious, because there is not an obvious mechanism for a reflector which would sweep the waves in front of it as it advances. In the æthereal case we can, however, on the basis of electron-theory, imagine a constitution for a reflector which will turn back the radiation on the same principle as a metallic mirror totally reflects Hertzian waves, and thus obtain an idea of how the force acts.

The case of direct incidence has here been treated for simplicity; that of oblique incidence easily follows; the expression for the pressure is reduced in the ratio of the square of the cosine of the angle of incidence. If we average up, after Boltzmann, for the natural radiation in an enclosure, which is incident equally at all angles, we find that the pressure exerted is one-third of the total density of radiant energy.

Adiabatics of an enclosed Mass of Radiation, and resulting General Laws.—Now consider an enclosure of volume V containing radiant energy travelling indifferently in all directions, and of total density E; and let its volume be shrunk by δV. This requires mechanical work $\frac{1}{3}\mathrm{E}\delta\mathrm{V}$, which is changed into radiant energy: thus

$$\mathrm{EV} + \tfrac{1}{3}\mathrm{E}\delta\mathrm{V} = (\mathrm{E} - \delta\mathrm{E})(\mathrm{V} - \delta\mathrm{V}),$$

where $\mathrm{E} - \delta\mathrm{E}$ is the new density at volume $\mathrm{V} - \delta\mathrm{V}$. This gives $\frac{4}{3}\mathrm{E}\delta\mathrm{V} = \mathrm{V}\delta\mathrm{E}$, or $\mathrm{E} \propto \mathrm{V}^{-\frac{4}{3}}$.

As already explained, if the original state has the constitution as regards wave-lengths corresponding to a temperature T, the new state must correspond to some other temperature $\mathrm{T} - \delta\mathrm{T}$. Thus we can gain work by absorbing the radiation into the working substance of a thermal engine at the one temperature, and extracting it at the other; as the process is reversible, we have by Carnot's principle

$$\tfrac{1}{3}\mathrm{E}\delta\mathrm{V}/\mathrm{EV} = -\delta\mathrm{T}/\mathrm{T},$$

so that $\mathrm{T} \propto \mathrm{V}^{-\frac{1}{3}}$.

Thus $\mathrm{E} \propto \mathrm{T}^4$, which is Stefan's law for the relation of the aggregate natural radiation to the temperature, established theoretically on these lines by Boltzmann.

Moreover, the Doppler principle has shown us that in the uniform shrinkage of a spherical enclosure the wave-lengths diminish as the linear dimensions, and therefore as $\mathrm{V}^{\frac{1}{3}}$, or inversely as T by the above result. Thus in the radiations at different temperatures, if the scale of wave-length is reduced inversely as the temperature the curves of constitution of the radiation become homologous, *i.e.*, their ordinates are all in the same ratio. This is Wien's theoretical law.

These relations show that the energy of the radiation corresponding to the temperature T, which lies between wave-lengths λ and $\lambda + \delta\lambda$, is of the form $\lambda^{-5} f(\lambda\mathrm{T})\delta\lambda$. The investigation, theoretical (Wien, Planck, Rayleigh, &c.) and experimental

[1] The present form of this argument arose out of some remarks contributed by Prof. FitzGerald, and by Mr. Alfred Walker of Bradford, to the discussion on this paper. Mr. Walker points out that by reflecting the radiation from a hot body, situated at the centre of a wheel, by a ring of oblique vanes around its circumference, and then reversing its path by direct reflexion from a ring of fixed vanes outside the wheel, so as to return it into the source, its pressure may be (theoretically) utilised to drive the wheel, and in time to get up a high speed if there is no load: the thermodynamic compensation in this very interesting arrangement lies in the lowering of the temperature of the part of the incident radiation that is not thus utilised.

(Lummer and Pringsheim, Paschen, &c.), of the form of this function f is perhaps the most fundamental and interesting problem now outstanding in the general theory of the relation of radiation to temperature. The theoretical relations on which this expression is founded have been shown to be in agreement with fact; and it appears that the form $c_1 e^{-c_2/\lambda T}$ fairly represents $f(\lambda T)$ over a wide range of temperature.[1] These relations have been derived, as usual, from a dynamical discussion of the aggregate intensity of radiation belonging to the temperature; it may be shown that the same results, but nothing in addition, will be gained by applying the same principles to each constituent of range $\delta\lambda$ by itself, assigning to each its own temperature.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxii., No. 4.—Asymptotic evaluation of certain totient sums, by D. N. Lehmer, is an attempt to account for what seems to be a remarkable law, first observed in particular cases in 1895. It is thus stated: Consider any set s of k linear forms, $an+b_i (i=1 \ldots . k)$, all of which have the same modulus a, and where $[a, b_i]=1$, $[a, b]$ stands for the G.C. divisor of a and b. Consider, further, a function $\theta_s(x)$ such that $\theta_s(x)=1$ or 0, according as each of the prime divisors of x belongs to one of the forms of the set s or not. If, then, $\nu(x)$ denotes the number of distinct primes in x, we have

$$\lim_{N=\infty} \frac{\sum_{x=1}^{N} 2^{\nu(x)} \theta_s(x)}{N} = \text{constant}$$

The author's aim here is to prove this law where s is the set of linear forms belonging to a binary quadratic form. He also determines the constant in this case (pp. 293–335). Dr. E. H. Moore's paper concerning Klein's group of $(n+1)!$-ary collineations is a modification of a communication made to the American Mathematical Society, December 30, 1898. This short note is related to several papers by the author, amongst others with one communicated to the London Mathematical Society (December 1896, *see* vol. xxviii., p. 357). The closing paper (pp. 343–380), is one by H. E. Slaught, entitled "The Cross-ratio Group of 120 Quadratic Cremona Transformations of the Plane. Part i., Geometric representation." The group specially studied is a particular case, $n=5$ of the general cross-ratio group of order $n!$ Its consideration was undertaken as a dissertation at the University of Chicago at the suggestion and under the direction of Dr. Moore, and so is closely connected with the two papers referred to above. A few plates of figures are given at the end of the number, and also an obituary notice of Prof. T. Craig by Prof. S. Newcomb.

Symons's Monthly Meteorological Magazine, December.—Climatological table for the British Empire for the year 1899. This interesting summary of the climatological tables which have been published for a number of selected stations for the last quarter of a century shows that, generally speaking, the extreme values fall much to the same stations as usual. Adelaide records the maximum shade temperature, 113°·6 (in February). This temperature has only once been exceeded in these tables—viz. by 114°·2 in 1876. It had also the maximum temperature in the sun, 175°·7; this value is also unusual, the only higher reading being 180°, in 1882. It is also the driest station, the mean humidity being 59. The dampest station was Colombo, mean humidity 79; this station also records the highest mean temperature, 81°·9, and the greatest rainfall, 73·5 inches. The lowest temperature in the shade was −46°·5 at Winnipeg (in February); this station had also the greatest range in the year, 135°·9, the greatest mean daily range, 22°·3, and the lowest mean temperature, 34°·2. Mauritius was the most cloudy station—viz. 5·7; this extreme has several times been recorded at London, but in 1899 the cloud value was 5·6, only three out of the preceding forty years having been less cloudy.

[1] This might, however, be multiplied by $(T\lambda)^k$, and the experiments would hardly discriminate between the values zero (Wien), unity (Rayleigh), and one-half (Thiesen) for k; the latter value, which is entirely empirical, seems to fit best.

SOCIETIES AND ACADEMIES.

LONDON

Royal Society, December 6.—"On the Bacterial Disease of the Turnip (*Brassica napus*)." By M. C. Potter, M.A., F.L.S., Professor of Botany in the University of Durham College of Science, Newcastle-upon-Tyne. Communicated by Sir M. Foster, Sec. R.S.

This paper gives the results of an investigation into the cause of a special disease of the turnip crop. The disease was discernible in plants still growing in the fields, some roots being found which were quite rotten, the decaying portion being white with a highly offensive and peculiar smell. The most careful microscopic search failed to detect any trace of hyphæ of the higher fungi in the decaying mass, but only a swarming mass of bacteria. The tissues were completely disorganised, the cells separating from each other along the middle lamella; the cell-walls were soft, swollen and faintly striated; the protoplasm, too, had lost its natural colour and become slightly brown and contracted. The disease could be readily communicated to sound, growing roots by merely making a slight incision and inoculating the root at the injured surface.

After a long series of cultures a bacterium was isolated, and pure cultures obtained grown from a single individual, which produced all the symptoms of "white rot" when sown upon sterile blocks of living turnip. This bacterium rapidly liquefies gelatine, it is a short, motile rod with a single polar flagellum, and, adopting Migula's classification, has been described under the name of *Pseudomonas destructaus*. When growing in a living plant tissue or in nutrient solutions, a cytase is secreted; this was isolated by the well-known method of precipitation by alcohol, and has been shown to cause the dissolution of the cells and the softening and swelling of the cell-walls of the host.

The appearance of the diseased tissue could not be entirely explained by the action of the cytase. It was found that the boiled, filtered juice of a turnip, which had become rotten through the influence of a pure culture of *P. destructaus*, had a powerful toxic effect upon the living plant cell. This toxin proved to be oxalic acid. A reaction probably takes place between the calcium pectate of the middle lamella and the oxalic acid produced by the bacteria, the calcium pectate neutralising the oxalic acid and thus permitting the continued growth of the bacteria.

The action of this bacterium upon living plant tissues is similar to that of some of the parasitic fungi; in both cases the invading organism produces oxalic acid, which acts as a toxin to the protoplasm and, decomposing the calcium pectate, furthers the dissolution of the cells; and also there is the secretion of a cytase, which has a destructive action upon the cell-wall and intercellular substance. The question of the parasitism of the bacteria thus stands in these respects on the same platform as that of the fungi, and a complete homology is established between them.

From numerous observations in the fields it would appear that *P. destructaus* is always introduced at a wounded surface, and through the agency of slugs and larvæ.

"On the Tempering of Iron Hardened by Overstrain." By James Muir, B.Sc., B.A., Trinity College, Cambridge, 1851 Exhibition Research Scholar, Glasgow University. Communicated by Prof. Ewing, F.R.S.

It is well known that iron hardened by overstrain—for example, by permanent stretching—may have its original properties restored again by annealing—that is, by heating it above a definite high temperature and allowing it to cool slowly. Experiments described in the paper, of which this is an abstract, show, however, that if iron hardened by overstrain be raised to any temperature above 300° C., it may be partially softened in a manner analogous to the ordinary tempering or "letting down" of steel which has been hardened by quenching from a red heat. This tempering from a condition of hardness induced by overstrain, unlike ordinary tempering, is applicable not only to steel, but also to wrought iron, and possibly to other materials which can be hardened by overstrain and softened by annealing.

The experiments described in the paper were all carried out on rods of iron and steel about ⅜ths of an inch in diameter and 11 inches long, the elastic condition of the material being in all cases determined by means of tension tests, in which the hardness of the material was indicated by the position of the yield-point.

The method of overstraining and examining the materials employed was analogous to that described in a paper by the present author, "On the Recovery of Iron from Overstrain" (*Phil. Trans.*, A., vol. cxciii., 1899).

Experiments described in the paper, of which this is an abstract, showed that with mild steel which had been hardened by tensile overstrain until it could withstand a load of 50 tons per square inch without yielding, no appreciable softening was produced by heating the material to 300° C. A temperature of 350° C., however, lowered the yield-point to about 47 tons per square inch; 500°, 600° and 700° C. lowered the yield-point to about 40, 35 and 30 tons per square inch respectively.

It was further shown that the same temperature brought the yield-point to approximately the same stress, no matter what might be the original hardness of the specimen under test; and that the harder the material was made by tensile overstrain—that is, the higher the yield-point was raised by permanent stretching—the lower was the temperature which could be shown to produce a slight tempering effect.

The results ascribed above solely to temperature were found to be influenced to some extent by time. Thus it was found that by baking a hardened specimen for several hours at any temperature a greater effect was produced than by simply raising the specimen for a few minutes to that temperature. The effect of time was, however, small compared with that produced by increase of temperature.

All the tempering effects observed with steel were also obtained with Lowmoor iron. The hardening by overstrain and the tempering of soft Lowmoor iron only differed in detail from the analogous hardening and tempering of steel.

The iron and steel employed in this research were also examined when in various conditions of hardness by means of the microscope, and micro-photographs are reproduced in the paper. The ordinary methods of relief-polishing and of etching by dilute nitric acid were employed, and a new method of staining steel by rubbing with ordinary moistened cocoa was made use of and is described in the paper.

Geological Society, December 5.—J. J. H. Teall, F.R.S., President, in the chair.—On the Corallian rocks of St. Ives (Hunts) and Elsworth, by C. B. Wedd. (Communicated by permission of the Director-General of the Geological Survey.) Starting two and a half miles south-west of Elsworth, the author traces the Elsworth rock at intervals through Croxton, Yelling, Papworth Everard, &c., to Elsworth, and thence towards Fen Drayton and near Swavesey. The Oxford clay is found to the west of it, and the Ampthill clay to the east. Frequent fossil lists are given, and the character of the rock is described at the different exposures. Again, from Haughton Hall, west of St. Ives, the "St. Ives Rock" is traced through that town and towards Holywell.—The unconformity of the Upper (red) Coal Measures to the Middle (grey) Coal Measures of the Shropshire coalfields, and its bearing upon the extension of the latter under the Triassic rocks, by W. J. Clarke. The Upper Red Measures have a much greater extension in the Shropshire coalfields than the productive Measures below. In the Shrewsbury field they are the only Carboniferous rocks present, and rest on pre-Carboniferous rocks. When the sections of collieries at and near Madeley are plotted on the assumption that the base of the Upper Carboniferous rocks is horizontal, the Lower Measures are found to be bent into a syncline rising sharply to the north-north-west and more gently to the south-south-east. A second syncline, broader and deeper, extends from Stirchly towards Hadley, but the westerly rise is often hidden by the boundary-fault of the coalfield. This phenomenon is known locally as the "Symon Fault"; and, instead of taking Scott's view that it represents a hollow denuded in the Lower Coal Measures, the author considers it due to folding before late Carboniferous times. A third little syncline occurs at the Inett and Caughley. Similar phenomena are exhibited in the Forest of Wyre coalfield, where a series of unproductive measures come in between the Lower and Upper Coal Measures.—Bajocian and contiguous deposits in the northern Cotteswolds: the main hill-mass, by S. S. Buckman. After giving comparative sections at Cleeve, Leckhampton Hill, and Birdlip, to show the disappearance of three horizons at the second locality and five more at the third, the author interprets the absence of the beds as due to "pene-contemporaneous erosion" brought about by the elevation of rocks, due to small earth-movements along a main south-west to north-east axis and subsidiary axes north-west to south-east.

Entomological Society, December 5.—Mr. G. H. Verrall, President, in the chair.—Mr. Jacoby exhibited specimens of *Hypocephalus armatus* from Bahia and *Chrysomela salisburiensis*, a new species, from Mashonaland.—Mr. Bower exhibited a specimen of *Spilosoma montanum*, an Asiatic species, bred from a larva found beginning of September 1897, feeding on birch on a moor near Paisley. The larva hibernated and spun a cocoon the following spring, not feeding after hibernation. Moth bred June 2, 1898. The moor on which the larva was found is used by the Glasgow Corporation for rubbish, the supposition being that an ovum or larva had been introduced with the refuse matter.—Mr. McLachlan exhibited a female of a dragon-fly of the genus *Tetracanthagyna* from North Borneo, similar to *T. vittata*, McLach., but with a very broad ante-apical fascia on the wings, and with some asymmetrical markings. He said there might be a question as to the specific identity or otherwise of the insect. There was also the question as to whether the insect described by Mr. C. O. Waterhouse as *Gynacantha plagiata* in the *Transactions* for 1878 was specifically the same. Mr. Waterhouse was of opinion that his insect was distinct.—Mr. R. Adkin exhibited two aberrant male specimens of *Argynnis aglaia*. In one of them the basal two-thirds of all the wings were almost completely covered with black, and broad black streaks crossed the remaining third of the wings to the outer margin, following the venation. In the other specimen the peculiarity consisted in the presence of a greenish-white blotch on each of the wings on the left side, similar in character to the pale blotches not infrequently observed in *A. paphia*. Both specimens were taken near Brighton in July last, where the species was unusually abundant.—Papers were communicated on observations on some species of *Orina*, a genus of viviparous and ovo-viviparous beetles, by Mr. G. C. Champion and Dr. T. A. Chapman, reported by Dr. T. A. Chapman; illustrations of the sixth male ventral segment in seventeen species of *Osmia* of the *Adunca* group, with a note on the synonymy of three species, and descriptions of five which appear to be new, by the Rev. F. D. Morice, M.A.; and an obituary notice of the late Dr. Otto Staudinger, by Mr. H. J. Elwes, F.R.S.

Linnean Society, December 6.—Mr. F. D. Godman, F.R.S., Vice-President, in the chair.—Dr. A. B. Rendle exhibited specimens, including leaves and fruit, of Grasswrack (*Zostera marina*, L.) recently found by Capt. H. P. Deasy near Yepal Ungar, in the Kwen Lun mountains, at an altitude of 16,500 feet. The plants were not growing in this remarkable locality, but were preserved in a bed 10 to 12 feet thick on top of and interspersed with which were strata of blue clay. The broken leaves and sheaths of which the specimens consisted were dry and brittle, but showed no alteration, the internal structure being as perfect as in the fresh plant. As the country is geologically unknown, it is impossible to estimate the age of the deposit. It probably formed the bed of a salt-lake. There is one in the neighbourhood; and Capt. Deasy is of opinion that the whole district formed at one time a large salt-lake. The specimens were very dusty, but microscopic examination of the dust revealed nothing beyond particles of sand and a few small brown objects, apparently spores of some kind. Capt. Deasy states that he saw similar growths in a lake in the same district, but was unable to procure specimens. This occurrence of *Zostera marina* in the heart of the Asiatic continent, and at so great an elevation, is of special interest. The plant, so far as known, is purely marine, occurring plentifully on our own coasts and throughout Europe, on the Atlantic shores of North America, and in North-east Asia. It has not previously been recorded from an inland lake, though an allied species, *Zostera nana*, L., occurs in the Caspian. Whether its existence in the Kwen Lun range has any relation to the Tertiary marine deposits which connect the Mediterranean area with the Himalayas is matter for conjecture. There seems to be some evidence for the existence of *Zostera* in Upper Cretaceous and Tertiary times; at any rate several species have been described from fossils resembling the rhizome of the plant, found in Central European beds. Dr. Rendle also showed a specimen of another marine monocotyledonous plant, *Halophila stipulacea*, Asch., from Tuticorin in Southern India, sent by Mr. Edgar Thurston. This species is not included in the "Flora of British India," nor in Trimen's "Ceylon Flora," a plant found by Dr. Harvey at Trincomalee, and thus determined by Thwaites, being assigned to the commoner *H. ovata*, Gaud. *H. stipulacea* occurs in the Red Sea, the Mascarene Islands, and Rodriguez.—The Rev. John Gerard exhibited some abnormally large shells of the swan mussel, *Ano-*

donta cygnea, forwarded from Claughton, Garstang, Lancashire, by Mr. W. Fitzherbert Brockholes. The three largest of these measured 8·75 inches, 8 inches and 7·5 inches in width, these measurements being considerably in excess of those given in the text-books, and of the examples figured as *Mytilus cygneus* in *Trans.* Linn. Soc. vol. viii. pl. 3, p. 109, and as *Mytilus stagnalis* (from Kew Gardens) in Sowerby's "British Miscellany," vol. i. pl. xvi. p. 33. It was stated that amongst other specimens found in the pond at Claughton, when drained, there was one of nine inches, twenty-eight measuring from 8 to 9 inches, and about a hundred of 7 to 8 inches.—Mr. F. Chapman read a paper on some new foraminifera from Funafuti, on which some remarks were made by Mr. Sherborne.—Mr. H. Groves, on behalf of Mr. G. C. Druce, communicated a paper entitled, A revision of the British thrifts (*Statice* and *Armeria*), in which he attempted a rectification of the synonymy, and discussed the value of the pubescence on the ribs of the calyx as a distinguishing character.

Royal Meteorological Society, December 19.—Dr. C. Theodore Williams, President, in the chair.—Mr. H. Mellish read a paper on the seasonal rainfall of the British Isles, which he illustrated with a number of lantern slides. He discussed the rainfall returns from 210 stations for the twenty-five years 1866-90, and calculated the percentage of the mean annual rainfall for each season. In winter the largest percentages of rainfall are found, as a rule, at the wet stations, and the smallest at the dry ones. Spring is everywhere the driest quarter, and the percentages are very uniform over the country, rather larger in the east then in the west. In summer the highest percentages are found in the dry districts, and the lowest in the wet ones. As the spring is everywhere dry, so is the autumn everywhere wet, and there is little difference in the proportion of the annual total which falls in the different districts. As regards the relation between the amount of rain which falls in the wettest and driest month at any station, it seems to be generally the case that the range is larger for wet stations than for dry ones. In wet districts rather more than twice as much rain falls, on the average, in the wettest month as in the driest, and in dry districts rather less than twice.

EDINBURGH.

Mathematical Society, December 14.—Mr. J. W. Butters, President, in the chair.—Dr. Third read a paper on triangles triply in perspective, and a paper on four circles touching a common circle, by Prof. Allardice, was communicated to the meeting by Mr. George Duthie.

CAPE TOWN.

South African Philosophical Society, November 28.—M. L. Péringuey, President, in the chair.—The Secretary read a paper by Dr. R. Broom, of Pearston, on the leg and toe bones of *Ptychosiagum*. Dr. Broom described a tibia and fibula, together with the greater part of two toes and a couple of carpal bones, found near Colesberg in association with the skull of *Ptychosiagum Murrayi* and presented to the Eastern Province Naturalists' Society by Mr. Leslie, of Port Elizabeth. The structure of the leg and toes confirm the view, based on the portion of the nostrils, that Ptychosiagum was an aquatic form.—Dr. J. D. F. Gilchrist read a paper entitled "The History of the Local Names of Cape Fishes." The object of the paper was to clear up certain difficulties caused by the use of different names and review their historical origin and development from a philological point of view. A list of over 200 names was procured, many of which were synonyms. These were arranged alphabetically, the synonyms grouped together and followed by the scientific name where possible. Traces of East Indian, French and Portuguese elements were found in the nomenclature, the most prominent being, however, Dutch and English.

NEW SOUTH WALES.

Linnean Society, October 31.—Mr. Henry Deane, Vice-President, in the chair.—Tasmanian land planarians: descriptions of new species, &c., by Thos. Steel.—Contributions to a knowledge of the Australian flora, Part iii., by R. T. Baker. A number of species of phanerogams and fungi not previously known to occur in New South Wales are recorded, as well as additional localities for already recorded New South Wales species.—Studies in Australian entomology: No. x., description of a new tiger-beetle from Western Australia, by Thomas G. Sloane.—Description of a specimen of kerosene shale from Megalong Valley, N.S.W., by Prof. C. E. Bertrand, Lille. A detailed description of the microscopic and macroscopic characters of a kerosene shale from Megalong are given. The shale belongs to the same type as the shales from Mount Victoria and Blackheath containing the alga, *Reinschia australis*. It is noteworthy, however, for the excellent state of preservation of the remains of the minute fossil forms. Associated with the alga are pollen grains and spores. The author has calculated that there are 16,830 thalli of *Reinschia* in a cubic millimetre of the shale.—On the "clouding" of white wine, by R. Greig Smith. A variety of chablis becomes clouded and turbid soon after bottling, which renders the wine commercially useless. The cause has been traced to an acetic-acid-forming bacterium which grows only upon wine and yeast-derived fluids. By inoculation of the pure organism into sterile wine, the trouble was reproduced. The remedy consists in pasteurising the wine.—On some new species of Eucalyptus, by R. T. Baker.

ST. LOUIS.

Academy of Science, December 3.—Mr. William H. Roever, of Washington University, read a paper on brilliant points and loci of brilliant points. The paper gave the analytical conditions which define the brilliant point of a surface, the brilliant point of a space curve, the brilliant point of a plane curve and the brilliant point in space of two dimensions, when the source of light is such that the incident rays are normal to a given surface and the recipient is such that the reflected rays are normal to another given surface. Formulæ were given for the important special case in which the source and recipient are points. The paper also contained a general method for finding the equation of the locus of the brilliant points of a moving or variable surface or curve, together with a number of applications. Such loci may often be perceived when an illuminated polished surface is rapidly moved, as when a wheel with a polished spoke is rapidly rotated. Another interesting example in loci of brilliant points is that of a circular saw which has been polished with emery in a lathe and thus received a great number of concentric circular scratches. The locus of the brilliant points of this family of scratches was shown in this paper to be a curve of the fourth degree. In the special case when the point source of light and the eye of the observer (the point recipient) are in a plane through the axis of the saw, the curve degenerates into a circle and two coincident straight lines.

CONTENTS.

THURSDAY, JANUARY 3, 1901.

THE NEW CENTURY.

SCIENCE is cosmopolitan. Electricity abolishes time and envelops both hemispheres with a new idea as soon as it has emerged from the brain of the Thinker. Mechanics, by its space-annihilating power, has reduced the surface of the planet to such an extent that the human race now possesses the advantage of dwelling, as it were, on a tiny satellite. Both these agencies, then, combine to facilitate a rapid exchange of new ideas and commodities, as well as of those who are interested in them in whatever capacity.

These considerations indicate some of the most momentous changes which have occurred in the world's history since the last century dawned.

How have they been brought about? M. Maurice Lévy, in one of those allocations—always so admirable in thought and style—pronounced by the President of the French Academy of Sciences at the annual public meeting held each December, answered the question for us last month.

"Let us never forget that if applied mechanics has arrived to-day at such marvellous results, if we can now calculate beforehand the parts of the most complex machines, it is because long ago the shepherds of Chaldea and Judea observed the stars; because Hipparchus combined their observations with his own and handed them down to us; because Tycho-Brahe made better ones; because two thousand years ago a great geometer, Appolonius of Perga, wrote a treatise on conic sections, regarded for many centuries as useless; because the genius of Kepler, utilising this admirable work and the observations of Tycho-Brahe, gave us those sublime laws which themselves have been considered useless by the utilitarians; and, finally, because Newton discovered the law of universal gravitation."

From this discovery of Newton, M. Lévy points out, first came the study of Celestial Mechanics, from which was derived later General Mechanics, from which again, later still, Industrial Mechanics, which are now applied every day, has taken its origin. He adds:

"It is well to impress the fact that Industrial Mechanics has come down from heaven, upon the utilitarians; upon those who appreciate science only so far as it can be immediately profitable to them; who are always complaining that too much is taught at school, and who regard as superfluous everything they cannot find in a formulary, manual or aid to memory."

All our progress, then, if we accept the view to which M. Maurice Lévy has given expression, has come from the study of what was useless at the time it was studied. There is no doubt that this view is correct, and that future developments, probably as momentous as those to which we have already referred, will in the future come to us from the same source.

To study the useless, therefore, is as important as to apply the useful, from a cosmopolitan point of view; and all wise governments and institutions should use their most strenuous efforts to aid the first endeavour, the second can very well take care of itself.

There can be no question that the progress of science and of the applications of science to industry will go on in a geometrical ratio, and that eventually every country will benefit by this advance; but if we quit the cosmopolitan point of view and endeavour to form an idea of the results of this advance on any country in particular, another set of considerations comes in.

Our Empire, as it exists at present, and our great national wealth, are the results of the sea-training and prowess of her sons and of the stores of natural wealth in the shape of coal and iron which the first appliers of mechanics found to their hand. The output and first user of coal and iron depended upon the applications of mechanics, and the first user of all these combined enabled us to flood the markets of the world, and for years Britain was the Tubal Cain among the nations. Not only had we a monopoly of export, but so high an authority as Sir Andrew Noble acknowledges that, fifty years ago, British machinery was immeasurably superior to any other. But even this statement does not exhaust all our then advantages. Because we were the great producers we became the great carriers of the world; hence the supremacy of our mercantile marine, and, flowing from this, our command of the sea. At that time Germany did not exist as a united nation, France was mainly agricultural, and the United States were engaged in developing their enormous and almost unpopulated territories.

But what has happened since? As we have said, science is cosmopolitan, and the levelling effect of this has been that the *material* advantages we possessed in the first instance have disappeared. Other countries, chiefly those we have named, have now their coal and iron and applications of science as well as ourselves.

First among these applications at the beginning of the last century came steam locomotion, the gift to the world of a former "instrument maker to the University of Glasgow," and from the work done on the Forth and Clyde Canal in 1802 have sprung all the navies and railways of the world.

For traction purposes steam is now giving way to electricity; but how different is the *rôle* that Britain is playing at the beginning of the new century compared with that she filled at the beginning of the old one. We import instead of exporting. The chief London electric railway is American, American coal is producing gas to light the streets of the Metropolis, American cars are now found on our English trains, which on some lines are drawn by American locomotives. British applications to facilitate locomotion, therefore, have ceased to be paramount, and at the same time we no longer occupy the proud position of being the only nation of shopkeepers.

Were this all, it would be abundantly clear that our old supremacy must cease, and from no fault of our own, as it is but a direct consequence of the general progress of science, which includes the facilitating of intercommunications. But, unfortunately, it is not all.

At a time when our ancient universities occupied no higher level than that, according to Matthew Arnold, of "hauts Lycées," and when there was little or no attempt at

educating the large majority of the population, Prussia, which, with the rest of the German States, had profited by Luther's appeal in favour of the education of the people, had occupied herself, crushed though she was after Jena, with the founding of universities and with the highest education; while live seats of learning in great numbers were being founded in the United States. The beginning of the new century, then, finds us in a position which every day differs more and more from that occupied by us in the old one, for not only are our natural resources relatively reduced in value, but our intellectual resources are not sufficiently superior to those of other nations to enable us to retain our old position by force of brains.

But even this statement does not truly paint the situation. From time to time since this journal was started in 1869, it has been our duty to insist upon our relative deficiencies in regard to the advancement of science and the higher scientific instruction. Thus, in the very first volume of NATURE, the absence here of the great facilities and encouragement given in Germany to these matters was clearly indicated. As an early instance of the result of this state of things we may refer to Mr. Perkin's account, in 1885,[1] of the migration of the coal-tar industry to Germany. In later years ample proof has been adduced that in many directions the present British intellectual equipment is not only not superior, but actually inferior to that of other countries, and none too soon the matter is engaging attention in the daily press. Within the last week the *Times*, *Daily Mail* and *Pall Mall Gazette* have called special attention to the reasons which may be assigned for this new and alarming state of things; a writer in the *Fortnightly* has gone so far as to ask, "Will England last the Century?" while Sir Henry Roscoe has expressed his opinions in a letter to the *Times* as follows:—

"There can be no manner of doubt that a crisis in our national well-being has already been reached. The news brought to us from all quarters proves that our industrial and commercial prosperity is being rapidly undermined. The cry that we are being outbid on all sides by Germany and America is no new one, but it becomes louder and louder every day, and now it is admitted by all those best qualified to judge that, unless some drastic steps are taken to strengthen our educational position in the direction long ago taken up by our competitors, we stand to lose, not merely our industrial supremacy, but the bulk of our foreign trade. . . . The only policy at this time is to strain every nerve to place the country educationally on a level with its neighbours. No effort, no expenditure, is too great to secure this result, and unless our leaders, both in statecraft and in industry, are quickly aroused to the critical condition of our national affairs in this respect, and determine at once to set our house in order, our children and grandchildren may see England sink to the level of a third-rate Power; for upon education, the basis of industry and commerce, the greatness of our country depends."

We must confess that when we come to consider the panaceas suggested by these writers we find much more vagueness than might be expected, and some suggestions which are entirely beside the mark.

Thus we are told that now our Colonies are being more closely united to us, we may rest and be thankful; that American industry depends for its success upon the extreme youth of those who are at the head of affairs. Education is referred to as if there were no differences in the methods employed, and finally a newly-developed sloth is suggested as the origin of the apparent decadence of the most athletic nation in the world.

The question arises, Is there no scientific method open to us to get at the real origin of the causes which have produced the present anxiety?

M. Maurice Lévy, in his allocation, did England the honour to point out how large a share Newton had in founding the industries on which our commercial greatness in the last century was based. It seems to us to be our duty, at the beginning of the new century, to suggest that at this critical time it would be criminal to neglect the labours of another great Englishman—Darwin—which may be appealed to to help us to see what has gone wrong and to forecast what the future has in store for us if we apply the suggested remedies or if we neglect them. In this we possess an advantage over our forerunners. Those labours have shown the working of an inexorable law which applies exactly to the conditions under which we find ourselves.

The enormous and unprecedented progress in science during the last century has brought about a perfectly new state of things, in which the "struggle for existence" which Darwin studied in relation to organic forms is now seen, for the first time, to apply to organised communities, not when at war with each other, but when engaged in peaceful commercial strife. It is a struggle in which the fittest to survive is no longer indicated by his valour and muscle and powers of endurance, but by those qualities in which the most successful differs most from the rest. We must accept the conclusion that, with material outfits now much more equally distributed for this struggle for existence, if Britain be at a disadvantage in relation to any other nation with regard to these qualities, it must go under if such a condition of things is allowed to go on. If this appeal to a natural law leads to such a dire conclusion, it is the duty of every Briton, from the highest to the lowest, to see to it that some efficient remedy be applied without delay.

It follows from what has already been stated that we need not look for these national differences among natural products for the reason that, day by day, such differences are being levelled by the present ease and rapidity of intercommunication.

We do not think that the differences will be found in any very great degree in our primary and technical instruction as it is going on to-day.

If we regard our primary, secondary and higher education, it must be acknowledged that great improvements have been carried out during the last quarter of a century. The establishment of new universities, adapted to the present conditions of civilisation, in several great centres and the promise of more, has clearly shown that, in the opinion of our most important mercantile communities, strong measures are necessary, and that they are prepared to make great pecuniary sacrifices to carry them out. Still, the facts show that what has already been done

[1] NATURE, vol. xxxii. p. 343.

is not sufficient, and that we must do more in these directions; but the present difference in these respects is not entirely sufficient to account for the present condition of things.

Continuing our process of exclusion we finally arrive at the possibility that the present superiority of our competitors depends as much upon Liebig's introduction of practical scientific work and research into the general higher education as did our former supremacy upon Watt's introduction of the steam engine. Voltaire said, "On étudie les livres en attendant qu'on étudie les hommes." The proper study of Science gives us a third term, the study of things and laws in action; a study in which the eye and hand and brain must work together to produce the scientific spirit or properly organised common sense.

The Scientific spirit existed among our European competitors much more generally than it did with us long before Liebig, and it was utilised over a far wider field of knowledge; but from Liebig's time it has existed among them as the dominant factor in Industry and Commerce, and the closer union between Science and Industry in other countries is, we believe, the true origin of the present difference between them and our own.

Here, we tried to start chemical industries by employing chemists, as Mr. Perkin has told us, at "bricklayers' wages." In Germany they are now carried on by scores, in one case a hundred, of the best trained chemists the country can produce, in research laboratories attached to all the great works. At this moment German artificial indigo threatens to replace the natural product in all the markets of the world as a result of these scientific industrial methods. So soon as Science was acknowledged to be the most important commercial factor, the Reichsanstalt was established by the Government at a cost of 200,000*l*., and a yearly expenditure of 15,000*l*. to weld science and industry more closely together. An American professor thus summarises the results:

"The results have already justified, in a remarkable manner, all the expenditure of labour and money. The renown in exact scientific measurements formerly possessed by France and England has now largely been transferred to Germany. Formerly scientific workers in the United States looked to England for exact standards, especially in the department of electricity, now they go to Germany." And again, "Germany is rapidly moving toward industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism, and the failure to utilise to the fullest extent the lessons taught by science."

Britain, of course, is the country in which such an institution ought to have been established more than half a century ago. We are now compelled to imitate it; but the new institution which, before long, may be instituted is on such a microscopic scale that its utility in the present struggle is more than doubtful.

The next conclusion the appeal to the law provides us with is that the improved scientific instruction of those engaged in Industry is not the only line along which our defences must be strengthened. The scientific spirit must be applied as generally in England as elsewhere.

The increasing complexity of industrial and national life requires a closer adjustment of means to ends, and this can only be attained by those who have had education on a scientific basis, and have therefore acquired the scientific habit. In this way only can we lift the whole standard of our national life to a higher plane, and weld the various national activities together.

We must have a profound change of front on the part of the Ministry and the personnel of Government departments, only very few of whom have had any scientific education and who at present regard all scientific questions with apathy, on the ground, perhaps, that in their opinion the Nation has no direct concern with them. This feeling may be strengthened by the fact that at present, while the laws of the realm are well looked after by the most highly paid servants of the State, the laws of Nature are left without anybody to form a court of appeal in difficult questions. It is true that to fill this gap our men of science are always ready, when called upon, to spend time and energy on affording, gratis, to the Government advice on any questions which may be submitted to them; but because this advice costs nothing its value is, perhaps, estimated by what it costs.

Our rulers must recognise that, in virtue of the law to which reference has been made, it will not do to confine their energies and the national expenditure, so largely as they do now, to matters relating to the Navy and Army, the functions of which are to protect our world-wide Empire at present well worth conquering, our industries, and our argosies on every sea—products, all of them, of our old scientific and therefore commercial supremacy.

Several obvious corollaries from the law in question indicate very clearly the proper course to pursue, in our own case to retain our position, in the case of our competitors to improve their own in relation to us, and therefore at our expense. There are many signs that our competitors, at all events, have faced this problem and are working on true scientific lines; of this the heavy subsidy of the German mercantile marine may be given as one instance out of many, and here, indeed, we are brought face to face with the consideration that the scientific outlook should really be as important to those in charge of the Nation's future well-being as that concerned with international politics.

If the other nations, by their scientific activity, increase their commerce and therefore their commercial fleets, their national fleets must be increased also. Our present policy with regard to our fleet is well established, so that we are committed to its continuous and well-defined increase, while it seems to be the duty of no Government department to look after the scientific advances which are the only bases of the commerce which is to provide for the constantly increasing expenditure. So that if, in the future, a constantly reduced commerce and commercial marine, and therefore reduced

national income, are in store for us, we shall have, because of this condition of things, to face a constantly increased expenditure upon our fleet.

These considerations are only typical of others which are well worth considering at the present juncture by men possessing the scientific spirit. What is the best way of utilising the combined forces of the Empire, in times of peace, under the present conditions? It is clear that no merely sentimental bonds will be sufficient. We may add that peaceful conflicts between industrial peoples are not alone in question.

With regard to preparation for war, history has already taught us much. Of two competitors, if one be fully armed both for offence and defence, and the other is not, there is no doubt as to what will happen. That nation will be the best off which utilises the greatest number of its citizens both for war and peace. A large standing army in times of peace is a clear indication that the scientific spirit has not been sufficiently applied to the problem, and it is to be hoped that now the future of the Nation is being discussed, the attempts to put our house in order will be made on scientific lines.

EDITOR.

RECENT ADVANCES IN THE CHEMISTRY OF THE PROTEIDS.

Chemie der Eiweisskörper. Von Dr. Otto Cohnheim. Pp. x + 315. (Braunschweig: F. Vieweg und Sohn, 1900.)

SINCE the publication of Drechsel's article on proteids in Ladenburg's Encyclopædia, no complete account of the chemistry of the proteids has appeared. The accounts given in the best known text-books of physiological chemistry are necessarily brief and incomplete. Dr. Cohnheim's book is therefore a very welcome addition to the literature of physiological chemistry, giving, as it does, a detailed account of the present state of knowledge with regard to the proteids.

The book is divided into a general and a special part. The first deals with the physical and chemical properties of the proteids, then with the products of their decomposition, and finally discusses their structure and classification. In the second part, the characteristics of the different forms of proteids are considered in detail.

In reviewing the book as a whole, it is impossible to do more than emphasise those features in which it shows a distinct advance as compared with its predecessors.

The chief characteristics which distinguish the proteids as a sharply limited class of organic compounds are the following. They contain the elements carbon, hydrogen, oxygen, nitrogen and, as a rule, sulphur in fairly constant proportions, and although their constitution is as yet unknown, the similarity in their chemical behaviour is so great that they may all be regarded as having a common chemical structure. Provisionally they may be divided into three groups, the native simple proteids, the compound proteids—in which a simple proteid is united to some other organic body—and the earlier decomposition products which still retain, in large measure, the chemical properties of the proteids from which they have been derived. The compound proteids may contain, in addition to the elements already mentioned, phosphorus and iron.

Their properties may be divided into physical and chemical. Taking the former first, the author selects, as their most characteristic property, the tendency of all native proteids to pass readily out of solution in the form of a more or less permanently insoluble precipitate or coagulum.

Means otherwise chemically indifferent, such as mechanical agitation of their solutions, contact with porous substances, or evaporation of part of the water of solution, result in the separation of a flocculent precipitate, which, on microscopic examination, is found to consist of minute particles tending to cohere so as to form membranes or threads of coagulated proteid. It is this property of proteids which explains their indiffusibility and the difficulty with which they undergo crystallisation.

Chief amongst the physical agents which produce this change is heat. To the subject of coagulation by heat a special chapter is therefore devoted. In the presence of a fixed quantity of neutral salt of the metals of the alkalies, and a very faint acid reaction, the temperature of coagulation is fairly constant for each native proteid, and has proved of considerable value in their separation and classification. A variation in the quantity or nature of the salt used alters the temperature of coagulation of any given proteid. Further, the proteid that separates out from a faintly acid solution carries with it some of the acid, so that the solution after coagulation is found to be less acid than before, or may even be neutral. The latter fact renders the coagulation of proteids by heat specially liable to fallacy as a method for their separation. The part played by the neutral salt in heat coagulation is still doubtful. Most observers have found that proteids, in solutions freed as far as possible from salts by dialysis, do not coagulate on heating; but the addition of a small quantity of neutral salt to the previously heated solution results in the separation of a coagulum. Cohnheim, therefore, regards coagulation by heat as invariably associated with the formation of an acid albumin insoluble in salt solution; but soluble in the least excess of the acid used. The evidence, however, on the influence exerted by neutral salts on the temperature of coagulation is conflicting. There is evidence that, in some cases, a proteid solution, freed as far as possible from salts by means of dialysis, coagulates at a lower temperature than when a small quantity of neutral salt is present. By means of dialysis alone it has not, as yet, been found possible to obtain a native proteid free from ash, so that the influence of heat upon a native proteid solution free from mineral matter has not yet been studied.

The next section of the book deals with the methods used for salting out proteids, and contains a complete account of the relative value of various salts as precipitants. Of all salts of the metals of the alkalies and alkaline earths, ammonium sulphate has the greatest precipitating power. Saturation with it precipitates all the native proteids from solution, and, with the exception of peptone, all the products of peptic or tryptic digestion still retaining proteid characters. Its precipitating power is increased by the addition of dilute acids, and, in the

case of some of the products of digestion, the addition of an acid is found necessary for precipitation. In neutral solution, the concentration of salt necessary for precipitation is found to vary with the nature of the proteid. Hofmeister and others have ascertained for a number of proteids the limits of concentration of ammonium sulphate necessary for their precipitation, and upon this basis have founded the method of fractional precipitation. By this means it has been found possible to separate from a mixture of proteids fairly well defined chemical individuals.

Another method of separation that is being used to an increasing extent is that of crystallisation ; but, unfortunately, its application is somewhat restricted. Dr. Cohnheim has, probably for this reason, relegated the subject to the second part of his book. Egg-albumin, serum-albumin and lactalbumin are the only simple proteids of animal origin that have been obtained in a crystalline form. The first method devised is due to Hofmeister. He succeeded in obtaining crystals of egg-albumin from egg-white by first of all precipitating the globulin by half saturation with ammonium sulphate. When the filtrate was allowed to slowly evaporate, egg-albumin gradually separated out in the form of minute globules. By re-dissolving the globules and repeating the process, he ultimately obtained well-defined crystals of egg-albumin which were purified by recrystallisation.

A much simpler and more satisfactory method has been discovered by Hopkins and Pinkus. After half saturating the egg-white with ammonium sulphate some ammonia is given off, and it was found that, after neutralising the ammonia with dilute acetic acid and then adding sufficient excess of acid to produce a slight precipitate of proteid, the crystallisation of the egg-albumin was rendered much more rapid. The crystallisation induced by this method occurs in closed vessels without any concentration of the solution, and therefore without the risk of the separation of ammonium sulphate crystals along with the proteid ones. Fifth normal sulphuric acid has been also used, instead of acetic acid, with similar results. Up to the present few attempts have been made to separate different forms of albumin by means of fractional crystallisation ; but, since the work of Hopkins and others has simplified the process, one may hope for farther applications of the method in the future. The method may possibly be found capable of extension to forms of proteid other than the albumins.

In the succeeding chapter an account is given of the average composition of the simple proteids, and of the methods used in determining their molecular weight. None of the physical methods that have as yet been tested are sufficiently delicate to permit an accurate estimation of the molecular weight of the proteids. Measurements of the lowering of the freezing point and of the osmotic pressure have been tried ; but are very difficult to apply on account of the practical impossibility of obtaining proteid free from admixture with inorganic substances. A full account is given of the chemical methods, which yield more trustworthy results. Although the risks of fallacy are numerous, the results yielded by the chemical methods in many cases render it possible to give at least a minimum value for the molecular weight.

The author passes in the next place to a consideration of the chemical characters of proteids. They have the character of potential acids or bases, according to the alkaline or acid reaction of the solution. When one compares the different forms of proteid, one finds that either the basic or acid character may predominate. The simplest forms of proteids, such as the protamines and histones, have a well marked basic reaction. The greater number of the remaining simple proteids play the part of base or acid with almost equal readiness. As a rule, however, the acid character is more emphasised. Simple proteids have, as acids, a distinctly dibasic character. The compound proteids, for example, nucleoproteids, nucleoalbumins and glycoproteids, have a still more marked acid character ; but in their case the acid reaction is mainly due to another organic group that has united with a molecule of a simple proteid.

In addition to these salt-like compounds of albumin, one finds compounds with inorganic material, for example, the halogens or iron, in which the halogen or iron is present in a more stable organic combination, and not as an ion. Some of these have been prepared artificially ; others by means of vital processes. It appears certain that the organism is capable of forming a stable organic compound of proteid containing iodine in which the character of iodine as an ion is lost, even when the only substances in the food given contained iodine in an inorganic form.

The chief characteristic reactions of proteids next considered may be divided into precipitation and colour reactions. In virtue of their basic character, most proteids, when in the presence of an acid, may be precipitated by the precipitants of the alkaloids. As acids, proteids form insoluble salts with most of the heavy metals. On these facts, methods have been founded for the estimation of the basic or acid equivalents of various proteids. Cohnheim illustrates this by the following example. The hydrochloric acid salt of a proteid and calcium phosphomolybdate = the insoluble compound of the proteid with phosphomolybdic acid and calcium chloride. Since the hydrochloric acid salt of a proteid reacts as an acid to phenolphthalein while calcium chloride is neutral, the diminution of acidity after precipitation can serve as a measure of the basic equivalent of the proteid. The more basic forms of proteid, for example, histones and protamines, are precipitable by reagents for the alkaloids from neutral or even alkaline solutions.

The colour reactions of the proteids are dependent on the presence of certain organic radicles in the proteid molecule, and owe their importance to the light which they throw upon the chemical structure of the proteids. The failure or success of any given colour reaction indicates the absence or presence of the corresponding organic group in the proteid molecule. By a careful study of the colour reactions and of the simpler decomposition products of the proteids, it may be possible in the future to subdivide the different proteids into structurally distinct classes, and thus to establish a classification of the proteids upon a chemical basis.

The most important of the colour reactions is the biuret reaction. The conditions necessary for its occurrence have been very fully studied by Schiff. It is given by all chemical bodies containing two $CONH_2$ groups united

either directly or by means of an atom of carbon or nitrogen. The oxygen in the $CONH_2$ groups may be substituted for sulphur without interference with the reaction. As all proteids give this reaction, the proteid molecule must contain at least one organic group corresponding to one of the three forms described by Schiff.

The simplest forms of proteid, the protamines, and their digestive products the protones, give the biuret reaction, but none of the other colour reactions of the proteids.

Kossel gives $(C_{30}H_{57}N_{17}O_6)_n$ as the formula of clupein, one of the most thoroughly examined protamines. On further hydrolytic decomposition, the protones yield the hexone bases, arginin, $C_6H_{14}N_4O_2$ (guanidin-α-amido-propionic acid), and histidin, $C_6H_9N_3O_2$, a base of unknown constitution. The hexone bases appear to be the only primary products of decomposition. Their relative proportion varies considerably, according to the particular protamine examined. None of these hexone bases give the biuret reaction, nor does any other one of the products of decomposition of the proteids of known constitution. The biuret reaction is therefore in general use as a criterion, distinguishing the proteid bodies in the widest sense from their simpler products of decomposition.

The protamines are chemically and, as the work of Miescher and others has shown, probably genetically the precursors of the more complex forms of proteid. The basic organic groups in proteid which give the biuret reaction are also the most resistant to the action of digestive enzymes, and make up the greater part of Kühne's so-called anti-group. Starting from these facts, Kossel has suggested that the nucleus of the proteid molecule has a structure resembling that of protamine. To this nucleus other organic groups become added, so as to form proteid bodies of more complex structure, and he has suggested that upon these facts might be founded a chemical classification of the different proteids. The steps of the synthesis of proteids within the organisms of plants and animals are still, however, too vaguely known to admit of such a classification. Further, Kossel's conjecture has not proved to agree completely with the facts, proteids being known which give a well-marked biuret reaction, although, upon hydrolytic decomposition, they yield a relatively small quantity of the hexone bases. One may therefore conclude that proteid bodies giving the biuret reaction do not always contain a protamine nucleus in the sense originally suggested by Kossel; but the evidence that a group of basic character giving the biuret reaction forms the nucleus of the proteid molecule is fairly conclusive. The biuret group may belong to any of the types defined by Schiff, and there is evidence that several biuret groups are present in the more complex proteids. One of these groups contains a relatively large percentage of sulphur.

The majority of the other colour reactions of the proteids are dependent on the presence of an aromatic or of a carbohydrate radicle. Millon's reaction is given only by bodies which contain a benzene group in which one atom of hydrogen has been substituted for hydroxyl. The xanthoproteic reaction indicates the presence of a benzene group.

The colour reactions resulting from the presence of a carbohydrate radicle may be grouped together as furfurol reactions. On heating with mineral acids many of the proteids yield furfurol, which may be detected by the colour reactions which it gives with α-naphthol and thymol. In those proteids which contain both an aromatic and a carbohydrate group, the addition of thymol or α-naphthol is unnecessary, a colour reaction being obtained by the action of the furfurol on an aromatic radicle split off from the proteid itself. The chief reactions which indicate the presence of a carbohydrate as well as an aromatic group are those of Liebermann and Adamkiewicz.

There are a number of other colour reactions which, as yet, have not been so carefully studied as those already mentioned. Of these the most important are Petri's diazo-reaction, which is also given by the hexoses and is, therefore, probably dependent upon a carbohydrate group, Würster's quinone reaction, which appears to depend on the presence of the tyrosine group in proteid, and Reichl's reaction with benzaldehyde, which is also given by indol and scatol. Dr. Cohnheim has omitted the discussion of the latter reactions, possibly because their significance has not been sufficiently determined.

Within the limits of a review it would be impossible to discuss the next section of the book, which deals with the simpler products of the decomposition of proteids resulting from the action of various hydrolytic agents, concluding with a very interesting account of the processes of decomposition in the metabolism of plants and animals.

After completing the study of the products of decomposition, Dr. Cohnheim gives a suggestive summary of the views held with regard to the mode of union of the elements present in the proteid molecule. It is noteworthy that in no part of the book is an account given of the various attempts to synthesise proteids.

At the outset of the following chapter, on the classification of proteids, the author shows a certain hesitation in adopting the usual method of classification, but ultimately decides that at present it is impossible to give a satisfactory classification based upon differences of chemical structure. He therefore practically adopts Hammarsten's latest classification, which, with some modifications, is essentially the same as that proposed by Hoppe-Seyler and Drechsel about fifteen years ago.

Limits of space will not permit one to give more than a brief reference to the remainder of the book. In the order of treatment of the subject, Dr. Cohnheim has adopted a significant departure from the order of classification.

An analogy is frequently drawn between the proteids and the carbohydrates in the sense that the native proteids are considered to bear to the primary products of their hydrolytic decomposition, namely, the proteoses and peptones, a relation similar to that which the more complex polysaccharides bear to the dextrins.

Under the influence of this analogy, Dr. Cohnheim deals with the chemistry of the proteoses and peptones before commencing his detailed account of the individual forms of proteid. One almost regrets that the author had not departed still farther from the usual order of treatment. Following Kossel's suggestion, he might first of all have dealt with the hexone bases and their anhydrides, the protones and protamines. Kossel originally proposed the name hexone-bases to mark the analogy

between them and the hexoses. The protones would, according to this scheme, be considered as comparable with the dextrins, and the protamines as comparable with starch. It is true that our knowledge is still too incomplete to enable us to carry the process still further, so as to trace with accuracy the connection between the protamines, on the one hand, and the proteoses and peptones on the other; but that need not prevent us from considering the subject in the order above described, especially since this arrangement has also the advantage of passing from the simple to the more complex. A short reference has already been made to the hexone bases, the protones and the protamines. To that account the following facts may be added. The protamines resemble other proteids in being lævorotatory, and have a toxic action similar to that of the albumoses. It is worthy of mention that, although the salts of the protamines with mineral acids are lævorotatory, those of the hexone base, histidin, are dextrorotatory. The protamines also resemble the proteoses and peptones in not being coagulated by heat.

Intermediate between the protamines and the native proteids lies a somewhat ill-defined class of proteids termed the histones. These have a well-marked basic character, being precipitated from their solutions by the addition of ammonia. They are not precipitated by heat unless a neutral salt of the alkalies be present, and even under those conditions they are incompletely precipitated. Within the organism they are never found in the free form; but always in combination with some other organic group, usually either nucleic acid or a pigment. It is asserted that they are occasionally found in the urine.

Their chemical properties place them in a class intermediate between the protamines and the simple native proteids. On account of their tendency to form compounds with other proteids, they appear to be well fitted to serve as precursors of the more complex forms of proteid. In neutral solutions they give precipitates with egg-albumin, serum-globulin, and caseinogen containing the two components in a fixed quantitative relation.

The most important recent advances in our knowledge of the proteoses are due to the work of Hofmeister and his pupils. They have applied the method of fractional precipitation by means of ammonium sulphate and of zinc sulphate to the separation of the proteoses resulting from the peptic digestion of various proteids, and, although it has not yet been found possible to separate by these means chemically distinct bodies, the complete separation of the proteoses into chemical individuals may be looked upon as a probable attainment in the near future. The chief difficulty of the separation is due to the fact that the proteoses, being all either of an acid or basic character, tend to unite together so as to form salt-like compounds. Only the briefest summary of the more recent results can be given here.

The proteoses may be divided into three classes.

The first class yields, on farther hydrolytic decomposition, a large quantity of monamido- and diamido-acids of the fatty series. It also contains a benzene radicle in which none of the hydrogen atoms are substituted for hydroxyl and a relatively large proportion of both loosely and firmly combined sulphur. It corresponds in type to Kühne's anti-group and, from the large proportion of diamido-acids which it yields, may be regarded as more closely allied to protamine than either of the two other classes. It is very resistant to hydrolytic agents.

The second class contains loosely and firmly combined sulphur, a benzene radicle in which one hydrogen atom has been substituted for hydroxyl and yields a relatively small quantity of monamido- and diamido-acids of the fatty series. It easily undergoes hydrolytic decomposition, and is termed the hemi-group.

The third class has been less thoroughly investigated. It is distinguished from the two former classes by the presence of a carbohydrate radicle, and is apparently absent from the molecule of many native proteids. One may regard the molecules of the majority of native proteids as being built up by the union of these three groups in varying proportions.

The chemical nature of the peptones is still the subject of much controversy. They are characterised mainly by not being precipitated by saturation of their acid solutions with ammonium sulphate, by giving a well-marked biuret reaction, and by yielding on farther hydrolytic decomposition the hexone bases amongst other products.

A detailed account of the individual native proteids is next given. Then there follows a description of the compound proteids which consist of one or more molecules of a simple proteid united with some other body, which may be either nucleic acid, chondroitinsulphuric acid, a pigment, or a nitrogenous derivative of the polysaccharides probably bearing the same relation to mucosamine or glucosamine as starch does to glucose. Cohnheim places the nucleoalbumins amongst the simple proteids, and suggests phosphoglobins as a more suitable name for the group.

The book terminates with a description of the chemical and physical properties of the albuminoids.

In conclusion, one cannot but feel that Dr. Cohnheim has earned the gratitude of both chemists and physiologists by his thorough review of the present state of knowledge of the chemistry of the proteids. In no other branch of chemistry is the literature scattered throughout so many journals of very diverse branches of science, and this makes the task of reviewing the literature a most arduous one.

As a work of reference the book is indispensable to all workers in physiological chemistry. J. A. Milroy.

MODERN LENS MAKING.

Contributions to Photographic Optics. By Dr. Otto Lummer. Translated and augmented by Prof. Silvanus P. Thompson, F.R.S. Pp. xi + 135. (London: Macmillan and Co., Ltd., 1900.)

Dr. Lummer and Prof. Thompson have given us in the above volume a thoroughly practical treatise on that part of optics with which it deals, and the book does much to prove the truth of a statement of the translator's preface: "In fact the science of the best optical instrument-makers is far ahead of the science of the text-books."

The history of the book is interesting. Dr. Lummer, when working up the subject of photographic optics for a new edition of Müller-Pouillet's text-book of physics

"looked about fruitlessly for a guide"; he found nothing to help him, and the volume now under review, which has been translated and amplified by Prof. Thompson, is the result.

Let us consider the problem; the photographer needs to produce on a flat surface an exact picture of a distant object. To take in a wide field of view the plate must subtend a considerable angle at the centre of the lens; the rays of light traverse the lens in very various directions, some are parallel to its axis, others are oblique, and the angle between them and the axis may reach 30° to 40°.

It is impossible to attain this result with any single lens; we must examine, then, in what respects an actual lens differs from the perfect instrument of Gauss's theory, what are its defects, and how they are to be remedied.

Now this theory is an approximation for real lenses depending on the assumption that the angle between any ray and the axis of the system is so small that all its powers above the first may be neglected.

We wish to inquire, then, what are the conditions which must hold in order that a refracting system may produce an image coinciding with that given by Gauss's theory, even when we retain in our mathematical theory powers of the obliquity above the first. This was done by L. von Seidel in the years 1856, 1857 (*Astronomische Nachrichten*, 835, 871, 1027-1029) for the case in which powers of the obliquity up to the third are retained. His work is hardly known in England. He found that to this degree of accuracy a perfect image could be obtained provided five separate equations of condition between the curvatures and refractive indices of the lenses and their distances apart were satisfied. These five conditions, which we may denote by $S_1 = 0 \ldots S_5 = 0$, are sufficient for all cases in which the light employed is of definite refrangibility; to correct, however, for dispersion, two other conditions are required, and the modern photographic objective, possible only in consequence of the discovery by the Jena factory of special "anomalous" glasses, is the outcome of the attempt to satisfy these conditions.

In the work before us no attempt is made to prove the above equations; this is not part of the scheme of the book, but it is shown that to each condition a distinctive physical meaning can be attached, and this physical meaning is brought into very clear light.

The first equation, $S_1=0$, is the condition that the image of a point on the axis may be a point, free, therefore, from aberration, even when the full aperture of the lens is used.

Let this be satisfied, and suppose the point source to move away at right angles to the axis to some neighbouring position, let the refracted beam be received on a screen perpendicular to the axis; in general, a blurr of light, more or less pear-shaped, will be formed at the screen; in some positions the narrow end of the pear is towards the axis, in others it is removed from it. The shape varies as the screen is moved, but unless the lens is corrected a point image is never formed. This is the defect or aberration called coma, so beautifully shown by Prof. Thompson to the Physical Society last session.

Now we know that when a *small* pencil of rays is obliquely refracted, the refracted rays diverge from two focal lines which lie in perpendicular planes; and we may look upon the finite pencil as composed of a series of small pencils incident at different parts of the lens. To each of these corresponds two focal lines, a primary and a secondary. But the refraction produced by the lens is such that the primary line belonging to a small pencil traversing the lens near its edge does not coincide with that of the central pencil. The primary focal line has a different position for each of the small pencils into which the finite incident pencil has been resolved; if, for a moment, we look upon the primary line as an image of the source, the position of this image depends on the portion of the lens by which it is formed. The next step, then, is to superpose these partial focal lines so as to form two single, primary and secondary, focal lines for the whole pencil, and this is the meaning of Seidel's second condition, $S_2=0$. This condition, which was known to Frauenhofer, is shown to be identical with a law distinguished as the Sine-law, which states that if P be a point on the axis of the system, and Q its image, and if a, a' be the angles which an incident ray through P and the corresponding refracted ray through Q make with the axis, then $\sin a/\sin a'$ is a constant for all rays. If a small object be placed at P, perpendicular to the axis, and a perfect image of this be formed at Q, then, as von Helmholtz showed, the ratio $\sin a/\sin a'$ measures the linear magnification of the image. The connection between this and the physical meaning of the condition $S_2=0$ is an obvious one.

But if this condition be satisfied, we are far from having a point image of our source; we have, instead, two linear images—one lying at right-angles to the axial plane through the point, the other, the secondary image, lying in that plane. If, instead of considering the image of a point, we deal with a plane cutting the axis at right-angles in P, we get, as the image of this plane, two curved surfaces, the one made up of primary lines, the other of secondary lines; these both cut the axis at right-angles in Q, the image of P. If by any means we can make the primary and secondary lines coincide, we shall have a point image of our point source; and this is done if the condition S_3 is satisfied. Such an image is said to be stigmatic, or sometimes an-astigmatic. If this be done for the whole field, the curved surfaces move up to coincidence; the image of the plane is a single surface, not two; in general, however, this image surface will be curved, and as we cannot dish out our photographic plate to get it, we must, if possible, make it plane. The equation $S_4=0$ expresses the condition for this.

Thus, if these four conditions are satisfied, we obtain a plane stigmatic image of any object lying in a plane normal to the axis of the lens.

But this alone is not sufficient to give us a perfect image; it must be similar to the object, there must be no distortion. It is found that the equation $S_5=0$ expresses the condition for this.

In some such manner as the above, Dr. Lummer and Prof. Thompson explain the meaning of the five conditions of no aberration, and then proceed to show how each is satisfied.

For the details of this the reader must refer to the book; there is one other point, however, which it is desirable to follow up more completely here. The

system must be free from chromatic aberration. Now let us, for simplicity, deal with two lenses in contact; let f, f' be their focal lengths, μ, μ' their refractive indices, and let $1/\nu$ $1/\nu'$ represent their dispersive powers, so that $\nu=(\mu-1)/(\mu_v-\mu_r)$, μ_v and μ_r being the indices for the rays it is desired to achromatise, while μ refers to some mean ray.

Then the condition for achromatism is

$$\frac{1}{\nu f}+\frac{1}{\nu' f'}=0.$$

Now it is shown in the book that for this case the condition that the field may be flat—Seidel's fourth condition—reduces to

$$\frac{1}{\mu f}+\frac{1}{\mu' f'}=0.$$

Thus the focal lengths must be of opposite sign, and the lens with least focal length—the concave lens that is in a photographic combination—must have the greatest refractive index. But, in order to satisfy the condition for achromatism, this same lens must have the greatest value for ν'.

Now achromatic lenses have usually been made by combining a convex lens of crown glass with a concave lens of flint; with such glasses, however, it is found that when μ is large ν is small, and *vice versâ*. Thus, for example, ordinary light flint has a greater refractive index than silicate crown glass, and hence an achromatic combination is possible; but since the value of ν for such flint is less than for crown, the combination when made will not give a flat field.

Dr. Lummer defines as an "old achromat" a pair of achromatised lenses made of such glass.

One of the results, however, of the experiments of Abbe and Schott at Jena has been the discovery that by the addition of barium salts a crown glass can be obtained having both a high refractive index and a high value for ν. Such a glass could take the place of the flint glass in an achromatic combination, and with this advantage, that the condition for flattening the field could be nearly, if not completely, satisfied.

The condition above given for a flat field was discovered by Petzval in 1843; in principle it had already been published by Airey ("Coddington's Optics," 1829). Von Seidel, however, was the first to point out that it was impossible with the lenses then available to satisfy both it and the condition for achromatism, and it was not until the Jena glass became available that an achromatic lens with a flat field was possible. Such lenses are called by Lummer "new achromats."

Having shown, in the first eight or nine chapters of the book, what are the conditions to be satisfied, Prof. Lummer proceeds to describe the various ways in which this is done in practice. The condition of no distortion is readily satisfied by combining two identical sets of lenses symmetrically placed into a double object glass with the stop midway between. These, if of the new "anomalous" glasses, can have a flat field. But such a combination will not be completely stigmatic; to secure this, other conditions must be satisfied besides those which are possible in a symmetrical combination, and the best result has been obtained by combining, in what is known as an anastigmatic-aplanat, a new achromat with an old achromat. The astigmatic effect of the old achromat is opposite to that of the new; hence by the combination it is possible to secure a flat image which is also stigmatic and achromatic, while, by adjusting the distance between the lenses and properly placing the stop, the condition of no distortion is satisfied.

Details of combinations satisfying these various conditions are given in the book, and not the least of Dr. Thompson's services are the chapters in which he calls attention to the excellent work done by various well-known English makers. His description of Dallmeyer's Tele-objective is specially welcome, while Miethe's two views of Munich from a distance of about two miles—the one taken with an ordinary lens, the other with his tele-objective—show what a powerful weapon the latter is.

The appendix contains some more detailed accounts of von Seidel's analysis, and also a valuable example of the computation of a lens.

The book is published by Messrs. Macmillan and Co. in their usual admirable style, and supplies a very real addition to the literature of a subject too much neglected in England. R. T. G.

OUR BOOK SHELF.

A Handy Book of Horticulture. By F. C. Hayes, M.A. Pp. xi + 225. (London: John Murray, 1900.)

THIS is a little book intended "for the class of fairly intelligent young men who are placed in sole charge of small gardens, who have little natural aptitude for gardening and no training, and who look in vain to their employers for teaching or suggestions of any kind." The questions naturally arise how such men come to have charge of gardens, and whether any book is likely to be of material service to them. For a class of better informed readers with a real interest in the subject the present book is better adapted, as the directions are simple and clear. The practical instruction conveyed is good, but, although the book is not intended for botanists, we may fairly look for accuracy and correct spelling of names.

In the following passages we have examples of loose writing, which are not the only ones that might be found:—

"The lilium is a popular family of hardy, bulbous flowers. No garden should be without a variety of them, but the species is so numerous that it would be impossible in one brief chapter to lay down general rules for their culture."

Here is another paragraph which is not remarkable for accuracy:—

"Speaking generally, a fern may be defined as a plant which bears leaves only and no flowers. The name of their order is Cryptogamia, *i.e.* hidden flowers; they have organs which produce spores, but the attractive petals are absent, and the spore cases are hidden away or take strange forms."

On the following page we have such misspelling as Calcidonicum and tigranum; elsewhere we find nemerosa, pyracanthus, azalias, Charles Lefebre; while the use or disuse of capital letters seems to be entirely a matter of caprice.

The Construction of Large Induction Coils; a Workshop Handbook. By A. T. Hare, M.A. Pp. 155. 35 illustrations. (London: Methuen and Co., 1900.)

THIS book, written by an amateur primarily for amateurs, will be found of the greatest use for all those, amateurs and professionals alike, who desire to construct Rhumkorf induction coils according to the most approved methods.

It is, indeed, so far as the present writer is aware, the only modern work which deals with the construction of large coils from a thoroughly practical standpoint. It describes in every detail the making of the apparatus, and contains much valuable information as to the general design of coils, the methods of winding and the processes of insulation, which hitherto have been the carefully preserved secrets of the very few makers of coils of the more powerful descriptions. Questions of cost are not omitted, while special chapters are devoted to contact breakers of the mercury, hand and electrolytic types.

The discovery of the Röntgen rays, and the important application that these have found in surgical and medical practice, together with the increasing employment of high tension electrical discharges in wireless telegraphy, spectroscopic analysis and other fields, have brought about a great demand for Rhumkorf coils of large size. The need for a book such as the one under review has therefore become increasingly felt of late years, and the only matter for regret is that the author did not give to the public the results of his experience at an earlier date.

The book is clearly written, well printed and well illustrated. A. A. C. S.

The Structure and Life-History of the Harlequin Fly (*Chironomus*). By L. C. Miall, F.R.S., and A. R. Hammond, F.L.S. Pp. viii + 196; plate and text illustrations. (Oxford: Clarendon Press, 1900.)

THE perfect insects of *Chironomus* are conspicuous objects on our windows, or may be seen dancing in swarms in the open air, and are often called "gnats," to which they have considerable resemblance; and, like gnats, the antennæ of the males are very plumose. The larvæ are found at the bottom of standing or slowly-running water, and those of some species are known, from their colour, as "blood-worms," while those of other species are green. The insects are easily collected and reared, and present many points of interest; and the work before us gives a very clear and fairly elaborate account of the structure and habits of these insects in their various stages. The life-histories of insects present an inexhaustible field for the investigations of any observers who care to devote their attention to this branch of entomology; and books like the present will give the beginner a very good idea of the best way to work on similar lines. Hitherto the Diptera, though one of the largest orders of insects, have been strangely neglected in England, and we have not even a good descriptive book on the order, though almost every Continental country has a good monograph in its own language. The interest felt in mosquitoes, however, at the present time will probably spread to other insects of the same order; and thus we are likely to see the study of their life-histories leading to that of the Diptera as a whole, instead of interest in the order generally, leading to researches into its life-histories, as has been the case with some of the other orders of insects.

The bulk of this work is too technical and too elaborate to admit of its being discussed in detail, and it contains much useful general information relating to allied species, nor are the parasites of the larvæ left unnoticed. One remark strikes us as specially interesting: "No insect is known to us which has more completely departed from the habits and structure of an air-breathing animal. Yet even here we find visible proof of descent from a terrestrial insect with branching air-tubes."

In an appendix we find a section on "Methods of Anatomical and Histological Investigation," and an additional note by Mr. T. H. Taylor on the swarming and buzzing of Harlequin flies. The book concludes with a good bibliography and index. W. F. K.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Nature of the Solar Corona, with some Suggestions for Work at the next Total Eclipse.

IN an article on the corona, published in the November number of the *Astrophysical Journal*, I suggested a method by which the existence of the Fraünhofer lines in the spectrum of the corona might be detected. The method was based on the supposition that the light emitted by the particles, in virtue of their incandescence, so overpowers the reflected sun-light that the lines are invisible. That the coronal light is strongly polarised is well known, and there is scarcely any doubt but that the polarised light is reflected sun-light. If, now, a Nicol prism be placed before the slit of the spectroscope in such a position as to transmit the polarised radiations, these will be allowed to pass with almost undiminished intensity, while the emitted or unpolarised light will be reduced in intensity by one-half. The great change in the ratio resulting might easily be sufficient to bring out the dark lines distinctly. I feel firmly convinced that this experiment should be tried at the Sumatra eclipse of next May, for I have successfully accomplished it in the laboratory with an artificial corona. It was found that a gas flame in a strong beam of sun-light shone with a pure bluish-white light, due to the reflection or rather scattering of the sun-light by the minute carbon particles.[1] The flame thus illuminated showed the Fraünhofer lines distinctly, but by reducing the intensity of the sun-light a point was reached at which they disappeared, and the spectrum appeared continuous. The light scattered by the flame was found to be completely plane polarised in certain directions, giving us just the required conditions, namely, particles emitting a continuous spectrum, and scattering a polarised solar spectrum. In front of the slit of the spectroscope a Nicol prism was arranged in such a manner that it could be drawn into and out of position by a cord. The Fraünhofer lines could be made to appear by sliding the Nicol in front of the slit, and disappear by drawing it away. While it does not by any means follow that the use of a Nicol on the actual corona will bring out the lines, the experiment seems to be well worth trying, as it would furnish further information regarding the relative intensity of the emitted and reflected light.

Another interesting point is that the minute particles in the flame do not scatter the longer waves, the flame reflecting practically no red or orange light. Thus the Fraünhofer lines can only be traced to about the D lines. By reducing the intensity of the sun-light they disappear, first in the yellow, then in the green, blue and violet in succession. This indicates that our chances of detecting the lines in the spectrum of the corona will be greatest in the photographic part of the spectrum. Moreover, it appears to explain the absence of radiant heat in the light sent to us from the corona, the particles being too small to scatter these longer waves to any appreciable extent. Abbott, of the Smithsonian party at Wadesboro', found the corona cold in comparison with his bolometer, and infers from this that the corona neither reflects sun-light nor emits light in virtue of incandescence, expressing the opinion that the luminosity is analogous to that of vacuum tubes transmitting electric discharges. It seems to me that the polarisation of the coronal light makes this theory untenable, and that the absence of heat rays can be explained fully by the small size of the particles. I am aware that the absence of radiant heat in the *emitted* light has yet to be accounted for. My own notion, based on experiments which are now in progress, is that the reflected or scattered light is vastly in excess of the emitted, and that the absence of the Fraünhofer lines is more probably due to the line-of-sight motion of the particles than to simple drowning out by emitted light.

My experiments on the ratio of emitted to scattered light of a body brought to incandescence by powerful solar radiation are not yet completed, consequently I do not yet feel prepared to make any very positive statement in regard to this matter. A

[1] Since writing the above I have found that the reflection of light by a flame has been described by Mr. Burch and Sir George Stokes indepen dently. It was noticed also by Soret at a still earlier date (1875) as I have subsequently found.

full account of this work will appear shortly in the *Astrophysical Journal.*

Any observers planning to use a Nicol prism in connection with a spectroscope in the manner described will find a gas or candle flame illuminated with a beam of sun-light, concentrated by means of a large mirror or lens, extremely useful in making preliminary experiments.

For work on the polarisation of the corona, I believe that the artificial corona, which will be described next week, will be found most useful for preparatory work. Not only is it polarised, and polarised in the same way as the real corona, but it resembles it in every respect, and can be easily made of the same brilliancy. It would be well to work with particles of different size, giving different percentages of polarisation, and the picturesque refinements for producing the polar streamers could, of course, be omitted. A lamp with a ground glass globe might be used to advantage, giving a distribution of polarisation more nearly like that of the actual corona.

Data regarding the plane of polarisation in the streamers would be useful in formulating a theory of the streamers. These, it seems to me, can be conceived as formed in two ways: they may be streams of coronal particles moving in curved paths, in which case the plane of polarisation should be everywhere strictly radial, or, what is extremely improbable, they may be caused by divergent beams of light coming from the polar regions of the sun and moving in curved paths owing to the rapid decrease in the refractive index of the sun's atmosphere in an outward direction. If this were the case, the plane of polarisation would turn with the streamer. This latter hypothesis is extremely visionary, and I do not present it seriously, for it is almost impossible to conceive of any way in which the isolated beams of light could be formed, unless, perhaps, by vortex funnels more highly luminous than the surrounding surface of the sun. Such fanciful speculations are hardly worth indulging in, though they have interested me for the moment in connection with the matter of possible curvature of light rays in the sun's atmosphere, alluded to in a recent paper by Julius in the *Astrophysical Journal.* R. W. WOOD.

University of Wisconsin.

The Alleged Decadence of German Chemistry.

As a man of business, more or less interested in the course of chemical discovery in so far as it affects chemical products of market value, I have for so many years been accustomed to take note of the rapid strides made by Germany in the chemical industries, that the statement contained in the article by "W. J. P." in your issue of December 27 (p. 214) has struck me with amazement. The writer says that "all students of contemporary chemical literature will agree that in Germany the science of chemistry has been in rapid decadence during recent years." This statement seems to me so completely at variance with my own experience that I have consulted chemical friends as to its accuracy, and I cannot find any chemist who agrees with this verdict. The consensus of opinion is, in fact, all in the opposite direction. "W. J. P." himself admits, as a generally recognised principle, that supremacy in any particular industry goes hand in hand with supremacy in the related sciences. Every one of the discoveries recorded in his own paper has been made in Germany, and he himself points out that the new industry is "almost wholly of German origin." Of course, as an English merchant, I hold no brief for German products, but having long ago recognised the importance of the connection between science and industry, which the author emphasises, and seeing what Germany has been doing of late years, I perhaps innocently attributed the progress of that country to their superior system of training in chemistry and related sciences, and to the readiness of their manufacturers to avail themselves of the results of scientific discovery. For the sake of British industry, I shall be only too glad to learn that I was mistaken; but since no chemist of my acquaintance agrees with the writer, and since he himself puts forward a whole body of German discoveries in order to tell us that chemical science is undergoing "rapid decadence" in that country, I cannot but feel that there is such a glaring contradiction between the facts recorded and the conclusions arrived at by the writer that some further explanation as to his meaning is necessary.

S. N. C.

Secondary Sexual Characters.

MR. POCOCK (p. 157) has replied to my letter, but he has not replied to my reasoning. It is no reply to say that it may be doubted whether my hypothesis is an improvement on certain others, when no reasons are given for the doubt. It is no argument to say that a problem is insufficiently supported by evidence, and may be true or false. A problem may be solved, but it cannot be either true or false, nor can it be supported by evidence. Mr. Pocock himself in his article attributed the colour of the male nilghaie and other antelopes to "male katabolism," which he now says is nothing but an imposing substitute for the "vital force" of the pseudo-scientific realists. I quite agree with him, and only hope that in future he will not explain male peculiarities by attributing them to male katabolism.

It is very difficult to reason with a naturalist who uses the terms "struggle for existence" and "influence of external conditions" as equivalent to "selection." I quite understand that to the Darwinian the only important action of external conditions is the selective action, the survival of the fittest. But the Darwinian does not appear to understand his opponents' conception of the modifying non-selective action of external conditions. Mr. Pocock does not distinguish between variations and modification. If any cause acts on *all* the males of a species and makes their colours dark or black, what effect can selection produce? If the dark colour is harmful, the species will become reduced or extinct. But selection cannot, as Mr. Pocock suggests, "check" a general modification due to a general cause without eliminating the species.

Thus the question which Mr. Pocock raised in his original article, and which he now "sets aside," the question of the initial cause of sexual modifications, is the essential question of the whole subject, and cannot be set aside in any rational discussion of the facts. Even supposing that the variations are different and not general, and that those which are beneficial are selected and preserved, selection offers no explanation of the fact that in so many cases the peculiarities in question are inherited only by the male sex. Mr. Pocock, in discussing the uses of coloration and markings, was obliged to refer to cases in which the males differed from the females both in colour and in horns. He has not yet realised the truth that no theories based on the conception of selection afford any explanation of unisexual inheritance.

Penzance, December 17, 1900. J. T. CUNNINGHAM.

The Word Physiography.

WITH reference to the question of the early use of the word Physiography to express the comprehensive study of Nature, to which you refer on p. 207 of your last issue, I should like to call attention to a fact which appears to have been almost forgotten.

The title-page of a "Dictionnaire des Termes usités dans les Sciences naturelles," published in Paris in 1834, bears as a motto the words—

"Profectò physiographiam qui colit, ullo pacto metam perfectioris cognitionis feliciùs non attinget, quàm si aliquot dies terminis perdiscendis tribuerit."—*Linné.*

I have tried, but without success, to find this quotation in the works of Linnæus; perhaps some of your readers may be able to supply the reference. The word Physiography was certainly current in Sweden about the middle of the eighteeenth century, as in the obituary notice of Torbern Bergman, read at the Stockholm Academy of Sciences in 1786 (which I know only in the German translation), it is mentioned that he became a member "der Physiographischen Gesellschaft in Lund, 1776." "Minerva" for 1900—1901, however, states that the Physiographical Society of Lund, which still exists, was founded in 1778 for the study of the scientific and economic conditions of the province of Scania. There was at the same time a Cosmographic Society in Upsala, and the two names seem to have been used much in the same sense.

I think it possible that the word Physiography was introduced in Sweden by Linnæus as a substitute for Cosmography, the ancestor alike of the Physiography of South Kensington, and the Physical Geography of the older text-books.

HUGH ROBERT MILL.

Artificial Rain.

AFTER the magisterial words of Prof. Cleveland Abbe, as reported in your issue of December 13, 1900, it requires some courage to offer a possible instance of "artificial" rain. I was near Bolton Abbey railway station on November 26 last. The atmosphere was perfectly calm, and a thin white mist enveloped the landscape. A number of land-blasting explosions took place in some limestone quarries, perhaps a quarter of a mile away. At a very short interval after these there occurred a very little shower or sprinkling of rain, just sufficient to cause me to put up my umbrella in preparation for more. The extreme brevity of the shower, and the peculiar conditions under which it occurred, arrested my attention, and led me at once to refer it to the explosions which had just taken place.

Keighley, December 22, 1900. C. H. B. WOODD.

IN an article on artificial rain in your issue of December 13, 1900, Prof. Abbe alludes to "the popular belief that rain follows great battles," which is now often—incorrectly, as the article points out—explained by and used as an indication of some effect produced on the clouds by the explosion of the gun-powder.

It is interesting in this connection to observe that the belief about rain following battles was held many centuries before the invention of gunpowder. Plutarch, in his life of Caius Marius, writes:—"It is observed, indeed, that extraordinary rains generally fall after great battles: whether it be that some deity chooses to wash and purify the earth with water from above; or that the blood and corruption, by the moist and heavy vapours they emit, thicken the air, which is generally liable to be affected and altered by the smallest cause." (Langhorne's translation). The inference is that the belief was the result of a preconceived idea, and that the gunpowder explanation was therefore wasted on a theory which was not grounded on observation at all. M. T. TATHAM.

Northcourt, Abingdon.

PROGRESS IN METALLOGRAPHY.

THE application of micrographic analysis to the study of alloys has given to the metallurgist a new and important field of investigation, and every improvement in the established methods is worthy of attention. Some of the latest suggestions are made by M. Henri le Chatelier in the *Bulletin de la Société d'Encouragement* for September last, the most noteworthy being in connection with the final stages of polishing. It is necessary for this work that the polishing powders should be perfectly classified according to the dimensions of the particles. The method of sorting by means of levigation, described by M. Osmond, is defective, owing to the fact that the salts of lime in ordinary water cause coagulation and rapid deposition of minute particles suspended in water. Caustic lime and acids induce even more rapid settling, a fact that has proved of great commercial importance in the treatment of ore slimes by cyanide in South Africa.

To overcome this difficulty the powders are heated with nitric acid, washed thoroughly, and allowed to settle in distilled water containing 0·2 per cent. of ammonia. When treating ten grams of powder in a litre flask, nine-tenths of the liquid are siphoned off at the following intervals of time: a quarter of an hour, one hour, four hours, twenty-four hours, and eight days. The third deposit is useful in polishing hard metals such as iron, but the fifth and last deposit affords the best polishing powder. Minute care is taken to avoid any admixture of dust or dirt with these powders, which can now be bought in Paris mixed into a paste with soap, and contained in tin tubes such as are used for oil colours.

A number of materials for the manufacture of these powders have been tried. M. Le Chatelier finds that alumina prepared by calcining ammonium alum is the best, as far as speed of polishing is concerned; but oxide of chromium, obtained from the combustion of bichromate of ammonium, answers fairly well in the treatment of iron and steel, and is better than alumina for soft metals such as copper. Oxide of iron is far less advantageous than these substances, its action being very slow. The soap

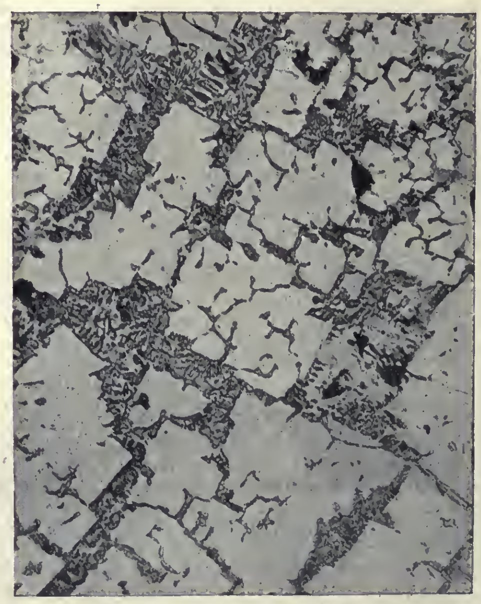


FIG. 1.—Crystals of Al_2Cu.

preparations are applied in the ordinary way to discs of wood or metal covered with skin or cloth and capable of being revolved at high velocity, the whole operation of polishing proper being carried through by their aid in five minutes.

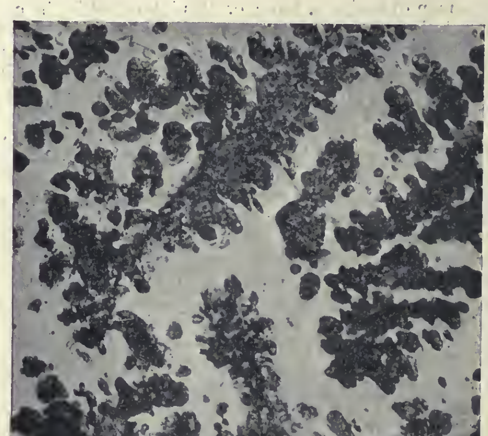


FIG. 2.—Compound near AlCu.

For examining and photographing the polished and etched specimens under the microscope, M. Le Chatelier proposes the use of monochromatic light such as that derived from an electric arc in mercury vapour, with

suitable screens between the source of light and the object to be illuminated; but it appears doubtful whether enough light can be easily obtained in this way for very high magnifications.

With regard to the selection of the specimens to be examined, it is well known that much time is wasted when working out a complete series of alloys of two metals. It is necessary to prepare, polish and etch a series of specimens, many of which will present no features of interest when examined under the microscope. M. Le Chatelier proposes to shorten the search for typical alloys by melting together two superimposed layers, each consisting of a pure metal, the lighter one being on the top. If no alloys are formed of greater density than the heavier metal, and the crucible is allowed to cool undisturbed, a culot can be obtained which, on being sawn through vertically, shows a complete gradation from one pure metal to the other, passing through the whole series of alloys, which can then be studied in one specimen. In this way he prepared a number of series, the three illustrations (Figs. 1, 2 and 3) being from

FIG. 3.—Crystals of $AlCu_3$.

photographs of different parts of a single specimen showing the aluminium-copper series. Fig. 1 shows crystals of Al_2Cu; Fig. 2, crystals of a compound of undetermined composition which is not far from that expressed by the formula AlCu; Fig. 3 shows crystals of the compound $AlCu_3$. It would seem that the exact percentage of any particular part of a specimen prepared in this way must be a matter of uncertainty, but there is no doubt that, in the hands of M. Le Chatelier, the method has already yielded some interesting results.

T. K. ROSE.

SOME RECENT ADVANCES IN GENERAL GEOLOGY.

AMONG the recent researches on organic remains none are of greater geological interest and importance than those relating to the Radiolaria. The tiny siliceous structures which belong to this Order of Protozoa have long been recognised in our formations, but the part they have played in building up portions of the stony structure of the earth has not until lately been realised. The most striking evidence was that brought forward by Prof. Edgeworth David and Mr. E. F. Pittman (*Quart. Journ. Geol. Soc.*, vol. lv. p. 16, 1899). They describe a great series of siliceous limestones, jaspers and claystones, with interstratified coral limestones and plant-beds, and submarine tuffs, the whole attaining a thickness of over 9000 feet, and extending over many hundred square miles in New South Wales. In the bulk of these rocks Radiolaria are present at the rate of about one million to the cubic inch, and among the forms Dr. G. J. Hinde has recognised twenty-nine genera and fifty-three species. Taken as a whole, the deposits are fine-grained, and bear evidence of having been laid down in clear sea-water, beyond reach of any but the finest sediment. They do not indicate any very considerable depth of water; but they tell of a vast lapse of time, and of conditions which prevented the dispersal over the area of coarse detritus. What exactly were these conditions it remains for future research to discover. In this country, in Devonshire and Cornwall, the occurrence of radiolarian cherts, both of Ordovician and Carboniferous ages, has been made known through the observations of Dr. Hinde, Mr. Howard Fox and Mr. Teall. The more prominent of these rocks are found in the Lower Carboniferous formation of Coddon Hill near Barnstaple, where the chert-beds have long been known, although their organic origin was not until recently discovered. The freedom of the beds from mechanically-formed detritus has led to the supposition that these strata were deposited in deep water and at some distance from the coast, although the associated strata above and below the chert-beds do not lend support to the hypothesis. The fact is that at the present time the only extensive radiolarian deposits known to be in process of accumulation are in the deeper oceanic regions.

Radiolaria, while entirely marine, are widely distributed, and they can exist at various depths in deep and shallow seas. It may be surmised, therefore, that in shallower areas coral-reefs may have acted as barriers to the dispersal of terrestrial *débris*. Hence in our explanations of the physical conditions of the past we must be guided by the general characters of the sedimentary strata in which bands and beds of radiolarian chert occur, rather than by the evidence of the chert itself. There is, however, little doubt, from the wide distribution of these lowly forms of life, that they may prove of considerable importance in the identification of horizons, although, as might be expected from their present geographical and bathymetrical ranges, some specific types have been of long geological duration.

In the coast ranges in California, and again in Borneo, such radiolarian rocks of Jurassic, or possibly Lower Cretaceous age occur, and it is noteworthy that Dr. Rüst has remarked that "the differences in the Radiolaria from these two rock-divisions are not very striking." (See Hinde's "Description of Fossil Radiolaria from Central Borneo," 1899.)

The question whether the Wealden strata which are essentially freshwater should be grouped as Jurassic rather than Cretaceous has been raised by geologists in the New as well as in the Old World, who have argued that the Wealden plants, fishes and reptiles are Jurassic rather than Cretaceous in character. There has never been any question in this country that the Purbeck and Wealden Beds are intimately connected both stratigraphically and palæontologically, and it has been held by some geologists that locally the Wealden Beds and Lower Greensand bear also evidence of continuous deposition. The subject was lately discussed by Mr. G. W. Lamplugh (Brit. Assoc., Bradford, 1900), who points out that in Dorset, Hampshire and Surrey there is evidence of the close stratigraphical connection between Wealden and Lower Greensand, that part of the

freshwater Wealden must represent true marine Lower Cretaceous beds elsewhere, and that consequently it is equally erroneous to classify the Wealden series entirely with the Jurassic system or entirely with the Cretaceous.

If the planes of division between our formations are more often than not ill-defined, so also are those between the main systems. Between our Palæozoic and Mesozoic strata there has never been a very well-marked boundary, for some authorities have placed the Permian with the older division and some with the newer.

The tendency of recent investigations in the midland areas is to show that a considerable series of red beds which have been regarded as Permian are truly portions of the Coal-measures, while it is evident that the Magnesian Limestone series is stratigraphically united more closely with the Triassic strata. In Britain the main mass of the Permian (Magnesian Limestone series, &c.) lies unquestionably with great discordance on various subdivisions of the denuded Carboniferous and Devonian rocks. Abroad in many areas, in India, Australia and elsewhere, there appear connecting links in strata grouped as Permo-Carboniferous; but it is a question whether the original Permian is anything more than a provincial set of strata, unentitled to rank with a system (see C. R. Keyes, *Journ. Geol.*, Chicago, vol. vii. p. 337, 1899).

As the history of the successive strata in different countries becomes better understood, so it becomes possible more closely to parallel the life-epochs which are represented in the rocks. Such life-epochs do not of course correspond with the sedimentary changes which are recorded by the rocks themselves, and hence a double system of grouping becomes needful. In our own country this has been long apparent, and the successive groups of strata which are so well established in the Ordovician and Silurian systems of Wales, the Lake District and the Southern Uplands of Scotland require distinct stratigraphical terms, while the life-history and the correlation of the subdivisions are indicated by the zonal groupings based on zoological evidence. The representation on maps and in sections of the main stratigraphical groups, or geological formations, is essential in order to show the physical structure of a country, not only in reference to economic questions, but also in regard to the influence on the present scenery of the rocks and the movements to which they have been subjected. Different types of landscape and the evolution of river systems are engaging a good deal of attention, notably in the United States; and the study has led to the introduction of a large number of terms which are rather difficult to remember, but the more important are explained in Mr. J. E. Marr's "Scientific Study of Scenery."

Increasing attention is given to the great movements which have affected the rocks especially in mountain regions. The pioneering work of Heim in Alpine regions has been utilised and developed in the most brilliant manner by Lapworth and Rothpletz and many others. The old ideas of reversed faults have been, so to speak, magnified into great earth movements, whereby huge masses of country have been overfolded, fractured, and overthrust, the older being pushed over the newer. On a small scale such overthrusts were long ago recognised in some coal-fields by the name of overlap faults, and the displacement was measured by yards—now it is sometimes reckoned by miles. Moreover, not only in Highland regions where the secret inferred by Nicol was unravelled by Lapworth have these mighty overthrusts been made manifest, but on a comparatively small but by no means unimportant scale they have been traced out and pictured in the Cretaceous rocks of the Isle of Purbeck by Mr. A. Strahan. The same observer has drawn attention to other overthrusts in the great Coal-field of South Wales.

All sorts of complicated structures due to cross-folding and faulting, to successive horizontal displacements and twisting, have been produced in mountain regions; and Dr. Ogilvie Gordon has dealt exhaustively with the subject in a paper on the torsion-structure of the Dolomites (*Quart. Journ. Geol. Soc.*, vol. lv. p. 560). To quote one sentence from her paper will, perhaps, be enough to give an idea of the puzzles she has attempted to solve: "Anticlines have been twisted round synclines, and the rocks in the synclines have themselves been twisted and distorted, buckled up and depressed, overthrust and faulted normally, cross-faulted and cleaved, to an extent that has not hitherto been realised." We may add that the subject of torsion-structure has been examined mathematically by Mr. J. Buchanan (*Phil. Mag.*, vol. l. p. 261).

The evidence of great folds and flexures, accompanied by overthrust faults, has lately been brought more fully to light in the Malvern region by Prof. T. T. Groom, while in the Lake District the field labours of Mr. J. E. Marr and Mr. A. Harker, as recently expounded (*Proc. Geol. Assoc.*, vol. xvi. August 1900), indicate that the country has there been affected, not only by overthrust faulting, but by more or less horizontal displacement, termed "lag" faults, whereby lower and older strata have been moved more rapidly than newer overlying strata, which consequently have lagged behind. Other faults, called "tears," are described, where, during these movements, rents have occurred in the shifting masses of strata without occasioning much vertical displacement.

In very many cases along fault-planes there has been produced a kind of breccia due to the effects of displacement, but more striking results of such action have lately been made known in the production of conglomerates. In such cases the effects of earth-movements have not only fractured, but actually worn away, the edges of the shattered rocks. In the Isle of Man, where the Manx slates have undergone acute folding followed by intense shearing, the shear-cleavage has cut and displaced bands of grit and has actually rounded the fragments so as to produce what Mr. Lamplugh has termed a crush-conglomerate. His observations have borne good fruit elsewhere. Mr. C. A. Matley has described crush-breccias and crush-conglomerates in Anglesey, where they occur "along zones of powerful crushing, especially in areas where the soft, fine-grained, slaty rocks alternate with tougher and more brittle strata, such as grits and quartzites" (*Quart. Journ. Geol. Soc.*, vol. lv. p. 657), and Prof. Groom has dealt with the crush-breccias of the Malvern Range (*ibid.*, p. 151).

It has long been felt that some revolution in palæontological nomenclature is needed, and, fortunately, the matter has been taken up boldly and effectively by Dr. Arthur W. Rowe.[1] In old times new species were named from fossils obtained from formations without reference to their special horizons. Some were founded on the evidence of but one or two specimens, and it has not unfrequently happened that "varieties" have been found which preceded in time the type species. Of late years, when increasing attention has been given to careful collecting, there has been a tendency to "make every prominent form a species, on the plea that every minute variation must be ticketed and pigeon-holed." In this way very many of the old land-marks have been removed, the study and identification of species have passed beyond the comprehension of any but the specialist, and the value of his labours to others has been more and more reduced or obscured. Dr. Rowe has now for some years devoted the leisure of a busy life to a careful collection of *Micrasters* from successive stages or zones in the Middle and Upper Chalk. He finds that by examining the facies of the genus in each horizon, passage-forms prove to be the rule, while sharply-defined and typical species are the exception. He has been able to trace an unbroken continuity in

[1] *Quart. Journ. Geol. Soc.*, vol. lv. p. 494.

the evolution of *Micraster*, so that in successive stages of the Chalk he finds variations in the structure of the tests, variations indeed which "are so marked that one can tell by their aid from what zone a *Micraster* is derived." As passage-forms and mutations form the bulk of the genus, it is necessary to mass certain obviously allied forms into groups which will admit of the zoological continuity being exemplified and the zonal peculiarities noted. This is the plan adopted by Dr. Rowe, and it certainly appears most philosophical to take a series of specimens rather than an individual as the foundation for a zonal specific type; and to group rather than to try and separate so many forms. It is satisfactory to learn that the detailed zoological work carried out by Dr. Rowe bears witness to the great value of the palæontological zones which were broadly marked out in the chalk of this country nearly twenty-five years ago by Dr. Charles Barrois.

There is no doubt that the careful collecting of fossils from definite horizons, and from horizons in definite sequence, is of the utmost importance in advancing palæontological knowledge. Such work, as a rule, requires prolonged labour, otherwise the conclusions are worse than useless. Now, by close research, it is possible to trace out the successive modifications that occur in stratigraphic sequence, and this has been attempted with the Graptolites, and with several groups of Mollusca and Brachiopoda, as well as with Echinodermata. Even in so variable a group as the Oysters, it is affirmed by Messrs. R. T. Hill and T. W. Vaughan (*Bulletin* U.S. Geol. Survey, No. 151) that these organic remains possess very distinct specific characters, have definite geologic horizons and are of the greatest value in stratigraphic work. Their value, moreover, may be not merely scientific, but also of some benefit to humanity. Instances have occurred in Texas where, by the aid of these fossils, brought up from great depths in diamond-drill cores, cities upon the point of abandoning the attempt to procure artesian water have been warranted in drilling a few feet farther, and with success.

Views on the duration of geological time have occupied a considerable amount of letterpress during the past fifty years, and during the past few years the subject has been discussed by Mr. G. K. Gilbert, Mr. J. G. Goodchild, Sir A. Geikie, Prof. J. Joly, and Prof. W. J. Sollas.

Mr. Gilbert would look to the influence of precessional changes and to the periodic modification of the climatic conditions of the two hemispheres. Contrasted phases of climate would thus occur every 10,500 years, and such changes should be looked for in the strata. Indications of moist or dry climates, of the increase or decrease of glaciers, and of the local fluctuations of sea-level as affecting the character and extent of strata are the indices to which he would appeal.

Prof. Joly, arguing from the amount of sodium at present contained in the waters of the ocean and the amount annually supplied by rivers, claims that a period of between eighty and ninety millions of years has elapsed since the land first became exposed to denuding agencies. Sodium, as stated by Prof. Joly, is the only dissolved substance of which the ocean has retained substantially the whole amount committed to it by the solvent denudation of geological time.

Prof. Eug. Dubois, dealing with the circulation of carbonate of lime, believes that the real lapse of time since the formation of a solid crust and the appearance of life upon the globe may be more than one thousand million years.

Mr. J. G. Goodchild in 1897 also argued that the more trustworthy data relating to the time of formation of marine strata were furnished by deposits of organico-chemical origin. He concluded that over seven hundred million years would be required since the commencement of the Cambrian period.

Although the conclusions arrived at by investigators are widely at variance, it is not improbable that some trustworthy data may in time be gained by the different methods of research advocated by Gilbert and by Joly. As lately remarked by Sir A. Geikie, progress in geology will be best made by the adoption of more precise methods of research and by a hearty co-operation among geologists in all parts of the world; and Prof. Sollas well observed in his address at Bradford that "our science has become evolutional, and in the transformation has grown more comprehensive." The work of the palæontologist must be supported by very detailed local field-work, work which at present is very much in its infancy. Such work will help in the grand story of "the science of the earth," a story whose materials can only be gathered together by the patient local toiler; while he or she may well be content to see the results worked up by those who by training and opportunity are able to take a comprehensive view of the earth as a whole.

H. B. W.

LORD ARMSTRONG, F.R.S.

THE death of Lord Armstrong on Thursday last, in his ninety-first year, will be regretted in the world of engineering and applied science. To the general public he was best known as a manufacturer of munitions of war, but engineers will remember him more for his developments of hydraulic machinery, and in science his name will be associated with the discussion of the duration of our coal fields, and the development, and discharge phenomena, of statical electricity.

William George Armstrong was born at Newcastle-upon-Tyne in 1810, and educated at a school at Bishop Auckland. He adopted the law as a profession, and became a partner in a firm of solicitors; but a strong bent for scientific pursuits led him to study mechanics with more interest than law and eventually diverted him into another career. Early in life he began investigations of electrical subjects, which resulted in the invention of the hydro-electric machine familiar to all readers of text-books of electricity. The circumstances which suggested this novel electrical machine are well known. The workmen at a colliery near Newcastle had observed that when steam was blowing off from the high-pressure boiler, a smart shock was received if the safety valve was touched, and sparks could be seen. An investigation of the phenomena showed Mr. Armstrong that the boiler was insulated on a dry seating, and the friction of the water particles against the sides of the orifice through which it was escaping caused a development of electricity. On this discovery he based the construction of his hydro-electric machine, which at that time formed the most powerful means of generating frictional electricity. It consisted essentially of an insulated boiler, from which steam at high pressure was allowed to escape through nozzles of peculiar construction. For this he was elected a Fellow of the Royal Society in 1846, while still comparatively a young man.

Another electrical research for which Lord Armstrong will be remembered was concerned with electric movement in air and water, and it culminated in the publication of an elaborate volume on the subject in 1897. In this work a striking experiment, performed with the hydro-electric machine half a century earlier, was made the starting-point of a valuable research on the nature of electric discharges. Two glasses of distilled water were placed near together, and a thread of cotton, which was coiled up in the one, had its free end placed so as to dip in the other. On negatively electrifying the glass of

water in which the cotton was coiled, and the other glass positively, the thread crept out of its glass into the other, while a stream of water passed in the opposite direction. This and other evidence led Lord Armstrong to conclude that an electric current consists of a negative stream flowing in one direction surrounded by a sheath of positive stream flowing in the opposite direction. The theory presents difficulties which have not been overcome, but neglecting it altogether, the photographs published to illustrate it are the most remarkable examples of electric discharges ever produced.

To Lord Armstrong the world is indebted for the development of the hydraulic machinery which to-day plays so important a part in the business of our docks and large railway stations. He first invented the hydraulic crane, and, between 1845 and 1850, the accumulator by which an artificial head of water is substituted for the natural head. By this invention hydraulic machinery was rendered available in almost every situation. Being very convenient where power is required at intervals and for short periods, it has come into extensive use for working cranes and hoists, opening and shutting dock gates, turning capstans, raising lifts, &c., and in many cases has procured important economies, both as regards time and money, at harbours and railway stations where large amounts of traffic have to be dealt with. In the Navy, again, its applications are almost infinite in number. In awarding the Albert Medal to Lord Armstrong in 1873, the Society of Arts recognised the benefits which have accrued to manufactures through his development of the hydraulic transmission of power.

For the manufacture of hydraulic machinery the Elswick Engine Works was founded, and there, in 1854, was constructed the first rifled ordnance gun that bears the name of Armstrong. Its trials were so satisfactory as regards range and accuracy that it was soon adopted by the Government, and Armstrong was appointed engineer of rifled ordnance, being made C.B. and receiving the honour of knighthood. Under his supervision some 3500 of these guns were turned out between 1859 and 1863, and England became the possessor of the best armament then in existence.

In 1863, Sir William Armstrong resigned his official appointment, and rejoined the Elswick Manufacturing Company, and in the same year he was president of the meeting of the British Association at Newcastle-upon-Tyne. In that capacity he drew attention to the gradual lessening of our supply of coal, and the prospects of exhaustion of our coalfields. The discussion suggested by this address led to the appointment of a Royal Commission to inquire into all the circumstances connected with the national coal supply, and he was nominated a member of it. The better utilisation of natural forces was a subject to which he again called attention in his presidential address to the mechanical science section of the Association at York in 1881, when he commented upon the wastefulness of the steam engine, and discussed the question whether its difficulties might be avoided by resorting to electrical methods of obtaining energy.

Lord Armstrong received many honours. Cambridge made him a LL.D. in 1862 and Oxford a D.C.L. in 1870. He was president of the Institution of Civil Engineers in 1882, and he more than once served the same office in the Institution of Mechanical Engineers. An original member of the Iron and Steel Institute, he was in 1891 awarded the Bessemer Medal by that body, and the large number of foreign decorations which were bestowed upon him attested the reputation which his work won for him abroad. His presidency of the Newcastle Literary and Philosophical Society was the occasion for several noteworthy addresses, and he wrote a number of articles, pamphlets and short treatises on scientific subjects. His public spirit and philanthropy are justly appreciated in Newcastle. A lecture hall for the Literary and Philosophical Society, an operating theatre for the Infirmary, thousands of pounds towards the restoration of a fine old steeple, other thousands to the Children's Hospital, three-quarters of a 20,000*l*. bridge across Benton Valley, 10,000*l*. to the Natural History Museum, a Mechanics' Institute, and schools for the Elswick men, a banqueting hall, public parks—these were among his gifts to the city.

For these works, as for his contributions to the progress of science and industry, his name stands high among the great men of the century.

WILLIAM POLE, F.R.S.

MR. WILLIAM POLE, F.R.S., whose death occurred on December 30, at the age of eighty-six, was distinguished both as an engineer and as a musician. He was born in Birmingham in 1814, and, after following the profession of engineering for some years, was appointed professor of civil engineering in Elphinstone College, Bombay. In 1847 he returned to London, devoting his chief attention to the mechanical branch of his profession, and soon became a recognised authority on engineering matters Between 1859 and 1867 he was professor of civil engineering at University College, London, and lecturer at the Royal Engineer Establishment, Chatham. He served on the Council of the Institution of Civil Engineers from 1871 to 1875, in which year he was appointed honorary secretary.

Mr. Pole's services to the Government in carrying out scientific work of various kinds were very important. In 1861–1864 he was a member of the committee on iron armour, and from that year till 1885 he was almost constantly employed by the Government in one of its departments, bringing the knowledge of an expert to bear on questions differing so widely as the comparative merits of the Whitworth and Armstrong systems of artillery and the gas and water arrangements of the metropolis. He acted as secretary to four Government commissions of inquiry—namely, from 1865 to 1867 to the Royal Commission on Railways, from 1867 to 1869 to the Royal Commission on Water Supply, from 1882 to 1884 to the Royal Commission appointed to inquire into the pollution of the Thames, and in 1885 to a committee on the science museums at South Kensington. From 1871 to 1883 he was consulting engineer for the Imperial railways of Japan, and on his retirement the Mikado decorated him with the Imperial Order of the Rising Sun.

In June, 1861, Mr. Pole was elected a Fellow of the Royal Society of London, and was vice-president in 1876 and 1889. He was elected into the Royal Society of Edinburgh in 1877, and into the Athenæum Club as a man of "distinguished eminence in science," in 1864. He published in 1844 a quarto treatise on the steam engine; in 1848 a translation of a German work on the same subject; in 1864 and 1870 "Scientific Chapters in the Lives of Robert Stephenson and I. K. Brunel"; in 1872 a treatise on iron; in 1877 he wrote the life of Sir William Fairbairn, and in 1888 that of Sir William Siemens. He was also the author of a well-known scientific work on the game of whist, and contributed a number of papers to scientific journals and periodical literature.

Mr. Pole was skilled both in the theory and practice of music. He took the Oxford degree of Bachelor in 1860, and in 1867 that of Doctor of Music. He also held for some years the office of examiner in music at the University of London. He was the author of "The Philosophy of Music," "The Story of Mozart's Requiem," and other compositions.

NOTES.

SCIENCE is represented in the list of New Year's honours by Sir William Turner, F.R.S., professor of anatomy in the University of Edinburgh, who has been made a K.C.B. Other names familiar in various branches of the scientific world are:—Dr. Thomas Barlow, physician extraordinary to the Queen, and Dr. W. S. Church, who have each received the dignity of a baronetcy; Mr. Hiram Maxim, the well-known inventor, has been knighted; Mr. F. Victor Dickins, Registrar to the University of London, and Lieut.-Colonel G. T. Plunkett, director of the Department of Science and Art, Dublin, have been appointed to the Order of the Bath (C.B.); and Captain F. E. Younghusband, known for his journeys in China and India, has been granted the Kaiser-i-Hind medal.

THE *Times* of Tuesday, December 25, contains an article on the dispute between the London United Tramways Company and the managers of Kew Observatory. It is written very much from the point of view of the Tramways Company, and contains several misstatements to which Prof. Rücker calls attention in a subsequent letter. The question, as Prof. Rücker rightly points out, is not whether it is possible to obtain "perfect" insulation, but whether the insulation, which every one knows can be obtained, should not be insisted upon when the interests of so valuable an institution as Kew Observatory may be preserved by doing so. The engineers of the Tramways Company originally proposed to limit the maximum potential difference between the rails and earth to one-fifth of a volt, a condition which was accepted by Kew, but they have since found that, by the system they proposed to adopt, they are unable to keep within this limit. There are, however, other systems which could be used, and it rests with the Board of Trade to decide whether some other system should be adopted or not. It is to be hoped that the final decision will enforce everything being done that can be done to prevent interference with the very important magnetic work carried on at Kew, or, if protection is considered impossible, that adequate compensation will be insisted upon. Quite apart from the particular point at issue, it is an anachronism which ought to be remedied as quickly as possible that electrical engineers should be allowed to let their waste current flow into the soil. The evils of the system are apparent in many instances already; they will become intolerable when electric traction is developed on a large scale in London.

AT the fourth International Zoological Congress, held at Cambridge in 1898, it was decided that the fifth Congress, in 1901, should be held in Germany; the selection of the town and president being left to the German Zoological Society, acting in conjunction with the Permanent Committee of the Zoological Congress at Paris. Announcement has now been made that the meeting place will be Berlin, on Aug. 12–16, and the president Prof. K. Moebius, director of the zoological collection of the Natural History Museum, with Prof. F. E. Schulze, director of the Zoological Institute, as vice-president. The secretaries of the Congress will be Herr P. Matschie, Dr. M. Meissner and Dr. R. Hartmeyer. The treasurers will be Herr H. Schalow and Herr Otto Stutzbach. Arrangements as to meetings and papers will be in charge of Prof. L. H. Plate, apartments and receptions will be under the care of Dr. L. Heck, and the lighter pleasures of the meeting will be managed by Dr. O. Jaekel. The meetings will be held in the Natural History Museum and neighbouring rooms of the University. Among the subjects to be brought before the Congress are the following:—Fossil remains of man, Prof. Branco (Berlin); vitalism and mechanism, Prof. Bütschli (Heidelberg); theories of fertilisation, Prof. Yves Delage (Paris); the psychological attributes of ants, Prof. A. Forel (Morges); the malarial problem from a zoological point of view, Prof. Grassi (Rome); mimicry and natural selection, Prof. E. B. Poulton (Oxford). After the conclusion of the Congress an excursion will be made to Hamburg for the purpose of visiting the Natural History Museum and Zoological Garden there, and also to Heligoland. Communications concerning the Congress should be made to the president, 43, Invalidenstrasse, Berlin, N. 4. Admission to the Congress will be free to all zoologists and all friends of zoology.

IN connection with the remeasurement of the Peru arc of meridian by a French Commission, M. F. Gonnessiat, of the Lyons Observatory, has been appointed director of the Observatory at Quito for a period of five years.

THE committee of the U.S. House of Representatives in charge of the Bill to substitute, in 1903, the metric system of weights and measures for the common system in use, has reported in favour of the change, and there is reason to believe that the Bill will become a law.

IT has been found necessary to postpone the opening of the Exhibition of Modern Illustration in the Indian Section (Imperial Institute Road) of the Victoria and Albert Museum, from January 7 until January 14. The Exhibition will be open free every day, and will remain open about three months.

AT the annual meeting of the Geographical Association on January 9, at the College of Preceptors, Mr. Douglas W. Freshfield, president of the Association, will show a series of lantern slides illustrating his recent journey in the Sikhim and Nepalese Himalaya.

WE are informed that the inaugural meeting of the Birmingham Local Section of the Institution of Electrical Engineers will be held in the buildings of the Birmingham University at 8 p.m., on Wednesday, January 23. Dr. Oliver Lodge, the chairman of the Section, will then deliver his address. The president and secretary of the Institution have accepted an invitation to be present.

WE learn from *Science* that Mr. D. O. Mills, of New York, has promised the University of California about 24,000 dollars, to defray the expenses of a two years' astronomical expedition from the Lick Observatory to South America or Australia, with the object of studying, under good conditions, the movements of stars in the line of sight.

THE monthly record of anthropological science, which has just appeared under the title of *Man*, ought to prove an excellent recruiting agent for the Anthropological Institute, under the direction of which it is published. The first number contains several articles and reviews on anthropology understood in its widest sense, and provides all who are interested in the study of man with a *précis* of important contributions to various branches of the science. A coloured picture of a Buddhist wheel of life from Japan forms a frontispiece, and is described by Mr. N. W. Thomas.

THE death of Major Serpa Pinto, the African explorer, is announced from Lisbon. He was leader of an expedition organised by the Lisbon Geographical Society and the Geographical Commission of the Ministry of Marine, for the purpose of exploring the hydrographical conditions between the basin of the Congo and that of the Zambesi, and generally to explore the whole region between the provinces of Angola and Mozambique. The expedition started from Benguella in November, 1877, and reached Durban in 1879. Little new country was opened up by the journey, as Africa had previously been crossed by Livingstone and other explorers. His contributions to a knowledge of the hydrography of the country between the coast and the Kwando were, however, of importance, and he was able to describe the large tableland that characterises

a considerable part of this region. The expedition was well supplied with scientific instruments, with which numerous observations that have been serviceable to the cartographer and the meteorologist were taken. The Royal Geographical Society awarded him their Founder's Medal for this journey. His travels from Mozambique in 1884, and into the Shiré country in 1889, were of political importance, but have no scientific value.

SIR HARRY JOHNSTON has sent to the Royal Geographical Society an account of his recent journeys in the Uganda Protectorate, and it is here abridged from the *Times*. He succeeded in making very interesting natural history collections in that part of the Congo Forest which stretches from the basin of the Ituri River to the vicinity of the Semliki. Many photographs were taken of the dwarfs, male and female, of their dances, implements and dwellings. Anthropological measurements were also made by Mr. Doggett, the collector accompanying the Special Commissioner's expedition. Other dwarfs were subsequently examined from the Mboga district, which is that outlying portion of the Uganda Protectorate which lies to the north-west of the Semliki River. It was found that (as other travellers relate) the dwarfs were of two types—black-skinned, with a good deal of stiff, curling black hair about the body, and red or yellow-skinned, with a tendency to redness in the hair of the head and yellowish-grey in the hair growing on the body. Some of the dwarfs, especially when young, have quite hairy bodies, and their women not infrequently have incipient whiskers. These Congo dwarfs no longer speak an original language of their own, but talk, in a slightly corrupted form, the language of the taller negroes in whose vicinity they dwell. Amongst physical features which specially distinguish them from their neighbours is the large size and flatness of the nose. This organ has scarcely any bridge, and the wings of the nose are very large. The dwarfs also have a very long upper lip, which is scarcely, if at all, erected. In many other points they exhibit ape-like features, but their intelligence is, as a rule, well developed, and though hideously ugly and often very ape-like in appearance, they are usually of a winning and cheerful disposition, while their dances are so frolicsome and gay and full of pretty movements as to distinguish them markedly in that respect from the average negro.

SIR H. JOHNSTON has ascertained that there exists in these Congo forests a remarkable species of horse or zebra not hitherto known or described. According to his observations, the gorilla as well as the chimpanzee exists in these Congo forests between the Ituri and the Aruwimi. He hopes to send home a specimen of the chimpanzee which is found in the western part of the Uganda Protectorate. Sir H. Johnston devoted three weeks to examining the upper part of Mount Ruwenzori. He and two of his companions ascended to a higher point, seemingly, than has yet been reached by any explorer. Beyond an altitude of 14,800 feet a succession of sheer walls of rock was found, the ascent of which was extremely difficult. Snow was found lying as low as 13,000 feet, and permanent snow was reached at 13,500 feet. A large botanical collection was made, and photographs were taken of the more remarkable forms of vegetation, which include two species of giant lobelia, a tree-heath grown to 50 feet, and the tree groundsel which was discovered by Sir H. Johnston in 1884 on the upper parts of Kilima-Njaro. Collections in zoology made on the mountain in this vicinity will probably result in at least one new species of monkey, a new hyrax, a new antelope, and a number of birds, reptiles and insects new to science.

DURING the past week this country has been visited by a series of severe storms, which have caused much damage to both life and property. On the morning of Thursday, December 27, the Daily Weather Report issued by the Meteorological Office showed that a "V" shaped depression lay over St. George's Channel, the distribution of barometric pressure being of a complex character, with high readings over both the north and south of Europe. During the day the depression moved eastwards across England, but was followed very closely by a new and much deeper disturbance. The centre of this storm passed across the northern parts of Ireland and England on December 27 and 28, and on the morning of the 29th the centre lay over Denmark, having travelled during some part of its course at about 23 miles an hour, while the velocity of the wind in the vortex reached over 80 miles an hour; at Greenwich the pressure anemometer registered 27 lbs. on the square foot in the afternoon of December 28. A further disturbance moved along our south coasts on the 30th and 31st, and occasioned northerly gales over a large part of England, during which some heavy falls of rain, amounting to 1—3 inches, were recorded in several parts of the country, resulting in disastrous floods.

THE report of the Meteorological Council for the year ending March 31, 1900, has recently been presented to Parliament. The principal changes during the year have been the appointment of Mr. W. N. Shaw as secretary, in succession to Mr. Scott, retired, and the appointment of Captain Campbell Hepworth, R.N.R., as marine superintendent, in place of Lieut. Baillie, deceased. The appendices contain (1) regulations for superannuation allowances to the established clerks, (2) correspondence referring to the continuation with the National Physical Laboratory of the relations hitherto subsisting between the Meteorological Office and Kew Observatory, and (3) further correspondence with H.M. Treasury and the Scottish Meteorological Society relating to the maintenance of the Ben Nevis observatories. A comparison of the evening weather forecasts (which appear in the morning newspapers) shows that the percentage of complete and partial success during the year amounted to 82. The success of the storm-warning telegrams issued to the sea coasts was even more gratifying, amounting to 91 per cent., while the warnings not justified by subsequent weather were only 4·8 per cent. The report contains an account of anemometer experiments made at Holyhead, and a note upon investigations in atmospheric electricity.

MANY years ago, a paper was published by H. Arons, dealing with the symmetry of crystals as deduced from their elastic potentials, in which it was shown that if a crystal possessed two planes of symmetry, then either the angle between the planes is 45°, 60°, or 90°, or every plane through their intersection is a plane of symmetry. In the *Atti dei Lincei*, ix., 10, Signor C. Viola now discusses the various forms of crystalline symmetry with reference to the so-called "law of rationality of the indices," and raises objections to this law. From considerations partly based on observation, partly on the theory of elasticity, Signor Viola gives a proof of the theorem that there are thirty-two different possible kinds of crystalline symmetry.

A METHOD of crystallising substances from albuminous solutions without the formation of a crust on the surface is described by Herr A. Wróblewski in the *Bulletin* of the Cracow Academy, viii., 1900. The method consists in confining the solution to be crystallised in a tube with a parchment bottom, and depends on the fact that evaporation takes place through the parchment although the surface exposed to the air shows no signs of moisture from the transpiration of the liquid. The apparatus which the author describes has enabled him to obtain crystals of albuminous substances of greater purity than those resulting from the use of Hoffmeister's method, and, moreover, it suggests several interesting experiments connected with osmotic phenomena.

IN his address on the future of anatomical teaching, delivered before the Middlesex Hospital Medical Society on October 18, and published in the December number of the Middlesex Hospital *Journal*, Prof. Alexander Macalister urges that much of the matter in our anatomical text-books might advantageously be omitted from what is taught to the over-burdened student. The essential thing for the future practitioner to learn is the position of the working parts of the human frame which affect his practice. In the case of the shoulder-girdle, for instance, he must know the precise shape of the articular surfaces, their extent of motion, where they are covered with muscle, and where the capsule is thinnest. But the minute description of the ligaments do not concern him. Neither need he know the relations of minute arteries in other parts of the body, or be taught the homology of, say, the human pterygoid bones. Not that what used to be called transcendental anatomy is decried by the professor. On the contrary, the importance of its study is extolled; but the ordinary medical student has not the time for it.

WE have received a paper by Messrs. D. S. Jordan and J. O. Snyder on fishes recently collected in Japan by Mr. Otaki and the U.S. steamer *Albatross*, published in the *Proceedings* of the U.S. Museum (vol. xxiii., pp. 335–380). Fourteen new species are described, several of which are referred to new generic types.

In the section of the *Papers* from the Harriman Alaska Expedition devoted to Diptera, Mr. D. W. Coquillet describes a considerable number of new forms, among them being a new genus —Ornithodes—of Tipulidæ. This most remarkable discovery is, however, the existence in Alaska of a species of Telmatogeton, a genus previously known only from St. Paul's Island in the Indian Ocean.

THE issue of the *Notes* from the Leyden Museum for January and April last (published in July and received a few days ago) opens with a communication from Mr. M. C. Piepers, in which the views advanced by him at the Cambridge Zoological Congress in regard to the evolution of colour in butterflies are defended against the criticisms of Miss Newbigin and others. The author urges that none save those who have made the morphology of the Lepidoptera their special study are capable of fully appreciating, much less of criticising, his views.

A SECOND article in the same issue, by Dr. F. A. Jentink, describes a remarkably coloured stoat in the Leyden Museum. After describing the gradual change from the brown summer to the white winter coat in the species and *vice versâ*, the author goes on to say that the example in question is striped in such a curiously symmetrical manner that it might well be regarded at first sight as representing an unknown species. The brown of the upper parts is locally interrupted by narrow bands of longer white hairs, which appear to be the remnants of the winter coat; and there are patches of white elsewhere—notably a ring dividing the black tip of the tail from the brown of the remainder of that appendage. The specimen was killed in Holland during the spring of 1869.

THE Geological Survey of Canada has published a useful general index to the reports of progress, 1863 to 1884. Since 1884 the successive annual reports have been separately indexed, but it is intended at a later date to prepare a general index to them. The volume before us, which contains full references to subjects, localities and authors, has been compiled by Mr. D. B. Dowling.

CRAGS of weathered granite in the Black Hills of South Dakota are described and pictured by Mr. E. O. Hovey (*Bull.* Geol. Soc. Amer., vol. xi). The granite is intrusive in the mica-schists of the region, but the schists have suffered most from erosion, so that the granite, which is intersected by numerous joints, stands up in places in sharp pyramidal and needle-like forms.

THE latest addition to Prof. Penck's *Geographische Abhandlungen* is a pamphlet on the three lakes of the Reschen-Scheideck, by Prof. Johann Müllner. The positions of the lakes, their supply areas, depths, surface levels, rainfall conditions and ice-covering, are dealt with in separate chapters, and besides the interest of its results the investigation forms another excellent example of the adequacy of the geomorphometric methods employed by the geographers of the Vienna school.

THE third number of the current volume of the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* is devoted to a review of the present state of knowledge of the geographical distribution of plants and animals, by Dr. Arnold Jacobi. The special problem dealt with is the position and form of biogeographical regions, and the bases on which such regions must be defined. A general map of animal distribution and special maps showing the distribution of the jay and the bullfinch accompany the paper.

THE November number of *La Géographie* contains the first part of a paper on the geography of the coast-region of the Landes, by M. Hautreux, well known for his work on the oceanography of the Bay of Biscay. M. Hautreux here discusses the wind records from a number of coast stations, with special reference to their influence on ocean currents and on the formation and movement of sand dunes. We note with satisfaction, from an announcement also in *La Géographie*, that the efforts of M. Hautreux during the last twenty years have borne fruit in the establishment of a "Société d'Océanographie du Golfe de Gascogne," to which we wish every success.

WE have received a copy of an official pamphlet on the currents of the Gulf of St. Lawrence, practically an abstract of the reports on surveys of tides and currents for the seasons 1894, 1895 and 1896. The information is arranged in a form likely to be specially useful to navigators; the surface currents in each locality are minutely described, and the causes of the general circulation in the Gulf are dealt with separately. One of the most important facts brought to light by the work of the survey is that no confirmation is forthcoming of the supposition that a current enters the Gulf by Belle Isle Strait and leaves it by Cabot Strait. The current flowing out by Cabot Strait apparently consists partly of water from the St. Lawrence and partly of water entering Cabot Strait itself on the eastern side.

THE November number of *Petermann's Mitteilungen* contains the third and last instalment of an important paper by Dr. L. Frobenius on the "Kulturformen" of Oceania. Dividing the region into four parts, in the west "Indonesia" or Farther India, in the south-east Australia, east Melanesia, and north-east Mikronesia, the author points out that there are three main lines extending from the first of these eastwards, a southern axis towards Australia, a central axis just skirting Australia, and a northern axis through the Mikronesian archipelago. To the civilisation of the southern axis the name "nigritic" is given, to that of the central axis "vormalaysian," and to that of the northern "malayo-asiatic." The paper is illustrated by an elaborate series of maps.

PROMPTITUDE of publication is now the distinguishing characteristic of the *Journal* of the Chemical Society. The January number of the journal contains the Rammelsberg Memorial Lecture (pp. 43) delivered by Prof. H. A. Miers, F.R.S., on December 13.

THE third volume of Prof. G. O. Sars's detailed "Account of the Crustacea of Norway" has been published by the Bergen Museum. It treats of the Cumacean group of Crustacea, which

is but imperfectly known; and it will be of service, not only for the determination of Norwegian species, but also for the future investigation of the Cumacean fauna of other countries.

DURING January, the following popular science lectures will be delivered at the Royal Victoria Hall, Waterloo Road:—January 8, History of the Solar System, Mr. F. Womack; January 15, Sea Coasts of Britain, Prof. H. G. Seeley, F.R.S.; January 22, Waves and Oscillations Mr. F. W. Porter; January 29, Niagara Water Power Installation, Prof. Capper.

THE Bath Natural History and Antiquarian Field Club has sent us a copy of its *Proceedings* (vol. ix. No. 3), containing among other contributions, a reduced copy of an old map of the Parish of Walcot, made in 1740. Then the parish was a little country village, now it is a great suburb of Bath. The notes on this map, by the Rev. C. W. Shickle, are of sufficient interest to make one wish they had been more extensive.

WE have received the November number of the *Victorian Naturalist*, the journal and magazine of the Field Naturalists' Club of Victoria. It is illustrated by some good views of the Basalt columns of Sydenham, and contains a variety of notes on local natural history.

IN the last number of the *Berichte der Deutschen Chemischen Gesellschaft* (33, 3307) Herr E. Buchner describes new experiments the results of which must be regarded as strong evidence in favour of the view that the active agent in fermentation processes is of enzymic character. Quantities of yeast were dried in vacuo at temperatures from 35°—100° C, and then heated for several hours in a current of hydrogen at 100° and then at 110° C. After this treatment the yeast has no fermenting power, as was conclusively proved by observations of its action on wort, the observations extending over a period of three weeks. The sterile yeast was then ground up into a paste with sand, kieselguhr and 10 per cent. aqueous solution of glycerin, and the mass subjected to strong hydraulic pressure. The liquid pressed out from the paste was found to have strong fermenting action. In spite of the sterilisation and the loss involved in the extraction with aqueous glycerine, the fermenting power was found to be one-quarter to one-half that of the original yeast. These experiments do not conform to the hypothesis set up by the opponents of the enzyme theory, that the fermenting power of press yeast is due to living protoplasm, for the latter is certainly no longer present in the yeast after its subjection to the sterilising process described. The specific action of the enzyme zymase is therefore not dependent on the presence of the living cell, and in this respect zymase is perfectly analogous to the active enzyme of urea fermentation isolated by Miquel.

THE additions to the Zoological Society's Gardens during the past week include a Derbian Zonure (*Zonurus giganteus*) from South Africa, presented by Major J. W. Jerome; three Bengal Monitors (*Varanus bengalensis*), a Conical Eryx (*Eryx conicus*), an Indian Eryx (*Eryx johni*) from India, deposited; two Bar-tailed Pheasants (*Phasianus reevesi*) from North China, twelve European Tree Frogs (*Hyla arborea*), European, purchased.

OUR ASTRONOMICAL COLUMN.

HELIOMETER MEASURES OF h AND χ PERSEI.—The great care taken and accuracy obtained by Prof. Wilhelm Schur in his observations with the fine Repsold heliometer of the Göttingen Observatory, make one regard the publications of the "Astronomische Mittheilungen von der Königlichen Sternwarte" as so many standard illustrations of heliometer reductions. The sixth part of this publication deals with the two bright star clusters, h and χ, in the constellation of Perseus. Both of these clusters have been measured before, the first by Krüger with the Bonn heliometer, by Bredichin with the micrometer, and by Karl Oertel with the large München refractor; and the latter by Vogel with the Leipzig 8-inch refractor, Pihl with the micrometer, and by Lohse and Bronsky and Stebnitzky from photographs. Prof. Schur compares his results with all these previous measures.

For his triangulation, Prof. Schur has used fifteen of the brighter stars in the two clusters; no less than 61 different distances have been measured, each distance having been determined on three, but generally more occasions. We must, however, simply restrict ourselves to the result of the whole investigation, which has led Prof. Schur to give the following final places for the stars he has employed; the consecutive alphabetical letters in the first column refer to the notation he has adopted in the chart of the region accompanying this publication. In the following summary the secular variation and proper motions have been omitted, and Kr. in the fourth column refers to Krüger's magnitudes:—

Positions of 15 *Stars in the Clusters h and* χ *Persei for the Epoch* 1893.75, *and Equinox* 1890.0.

	B.D.	Mag.		R.A.	Precession	Declination.	Precession.
	+ 56°	B.D	Kr	h. m. s.	s.	° ′ ″	″
a	471	6·6	6·7	2 9 10·477	+4·1533	+56 32 35·06	+16·952
b	479	8·9	8·9	9 34·736	·1409	23 11·21	·933
c	498	8·6	8 6	10 40·779	·1628	30 0·98	·880
d	500	8·5	8·5	10 44·886	·1715	41 54·73	·877
e	530	6 7	6·4	11 30·237	·1756	39 37·93	·842
f	543	8 0	8 2	12 11 145	·1870	48 38·09	·809
g	545	8·5	8·6	12 31·519	·1803	35 29·12	·793
h	547	8 2	7·2	12 45·113	·1775	29 10·59	·782
i	555	8·8	8·4	13 26·604	·1773	21 35·55	·749
k	567	8·4	8·3	14 7·833	·1841	24 1·19	·716
l	568	6·7	6 6	14 9·189	·1985	44 17·45	·715
m	593	7·0	7·0	15 12·596	·2127	53 2·12	·663
n	595	8·5	8 3	15 24·027	·2060	41 47·75	·654
o	598	8·4	8 6	15 38·363	·1930	21 6·48	·642
p	603	9·2		2 17 4·986	+4·2125	+56 32 54·63	+16·572

This triangulation will form a fine groundwork for future photographs of the fainter stars in this region, for the constants for the reduction of the plates can be determined by the heliometer positions of the brighter stars. The great value of heliometer measures as forerunners of the photographic plate is a point that cannot be overlooked when dealing with star clusters, nebulæ immersed in stars, or *vice versâ*.

ANNUAIRE POUR 1901 BUREAU DES LONGITUDES.—This useful annual, issued under the direction of MM. Janssen, Cornu and Lœwy, is compiled in similar manner to previous issues. A complete calendar, with the usual solar and lunar data, lists of celestial phenomena for the year, comprising occultations, eclipses, maxima and minima of variable stars, elements and ephemerides of the planets, shooting stars, &c., occupy some three hundred pages. An important notice is issued stating that all the times given in the volume are expressed in *civil mean time*, reckoned from 0h. to 24h., commencing at midnight.

A lengthy appendix is occupied by a dissertation on the electrical transmission of power, by M. Cornu, and other articles are contributed by M. Poincaré (Revision of the Meridian Arc of Quito); M. Lœwy (Astronomical Conference at Paris); M. Bassot (Foundation of the Metric System); M. B. de la Grye (International Geodesy), and M. Janssen (Work at the Observatory on Mont Blanc).

CATALOGUE OF STARS.—The sixth volume of the publications of the Hamburg Observatory consists of the reduced places of stars between 80° and 81° north declination, determined with the Repsold meridian circle of 10·8 cm. aperture and 1·62 metres focus. The stars are arranged in 69 zones, an index being furnished to show the various zones containing each object.

NEW MINOR PLANETS.—A telegram through Laffan's Agency from New York, dated January 1, says:—Mr. W. R. Brooks has discovered by means of photographs three new planets within one degree of Eros. The brightest is somewhat brighter than Eros.

SPAIN AND GREENWICH TIME.—After midnight of the 31st of December last, Spain began the new century by adopting officially throughout the country Greenwich time, the hours being numbered one to twenty-four.

THE USE OF BLAST-FURNACE GASES IN GAS ENGINES.

DURING the past year all the difficulties in the use of blast-furnace gases have successfully been overcome, and it is interesting to consider the rapid progress that has been made in this important development of metallurgical practice. The question was first taken up by Mr. B. H. Thwaite in 1894, and a 15 horse-power engine, worked by blast-furnace gas purified by his apparatus, was set to work at Wishaw, in Scotland, in February 1895. Since that date numerous small motors have been in operation in this country using purified blast-furnace gas driving machinery and dynamos. In the development of large motors and in their adaptation to blowing engines Belgium has taken the lead. In May 1898, Mr. A. Greiner, of the Cockerill Company, described a 200 horse-power engine in successful use at his works. The results attained stimulated experiment in Germany and in Luxemburg. The Cockerill Company, however, continued to take the initiative by starting, on November 2, 1899, the largest gas engine ever built. On May 9, 1900, Mr. Greiner described the engine to the Iron and Steel Institute, and gave the results of six months' working. This was the first gas engine to run the blowing engine of its own furnace. Results of tests of this gas engine, by Prof. Hubert, of Liége, are given in an appendix to an exhaustive paper on power gas and large gas engines, read by Mr. H. A. Humphrey before the Institution of Mechanical Engineers on December 14, 1900. The engine was designed by Mr. Delamare-Deboutteville, and built by the Cockerill Company. It is a single cylinder 600 horse-power engine, working on the Otto cycle, and direct coupled to a double-acting blowing cylinder. The large engine and blower shown by the Cockerill Company at the Paris Exhibition was a duplicate of the one under discussion. It was rated at 700 horse-power on blast-furnace gas, at 800 horse-power on producer gas, and at 1000 horse-power on illuminating gas. In an exhaustive paper on the subject, published by Prof. Joseph W. Richards in the current number of the *Journal* of the Franklin Institute of Philadelphia, the following list of blast-furnace gas engines now in operation is given:—

	No.	Horse-power.
Seraing, Belgium	4	500
Differdingen, Luxemburg	4	500
Hoerde, Westphalia	2	600
	2	1000
Friedenshütte, Silesia	2	200
	2	300
Oberhausen	1	600
Dudelingen	2	600
	2	1000
Kneutingen	2	500
Roechling	1	200
	2	600
Ruhrort	1	500
Barrow, England	—	1000
Toula, near Moscow	3	600
	3	200
Island of Elba	—	1000

The Cockerill Company is now constructing, for the Roechling Ironworks in Lorraine, three 1200 horse-power gas engines. They are double-cylinder tandem engines directly attached by a tail rod to the blowing cylinder. The Cockerill Company and Mr. Delamare-Deboutteville have now decided to build engines of 2500 horse-power. They will have two tandem cylinders on each side of the dynamo, giving four cylinders per engine. They are designed for a central electric station.

In view of the remarkable results already attained, there can be no doubt that during the next few years the design and erection of large central power-stations for the generation and distribution of electric energy in bulk will be one of the most important problems with which engineers will have to deal. The new stations will be larger than any now existing, and every possible effort will be made to reach an unprecedented degree of economy in the production of power. Mr. Humphrey's paper strongly urges the claims of the gas engine to rank as a rival of the steam engine for large power units. The results of a trial of a 400 horse-power Crossley gas engine carried out by Mr. Humphrey are certainly most satisfactory, whilst its capability for continuous work has been shown at Messrs. Brunner, Mond and Co.'s works at Winnington, Cheshire, where it is used for their electrolytic plant. The employment of gas engines in large central station work is, however, still very limited, for out of the total of seven central stations where gas motors are used, the largest has only an aggregate of 650 horse-power, whilst the largest unit is of only 200 horse-power. The use of the waste gases from blast furnaces renders it possible to have a supply of cheap fuel. This result can also, according to Mr. Humphrey, be attained by the use of a Mond producer plant, which is suitable for converting cheap bituminous fuels into suitable gas for gas engines, and at the same time permits of the recovery of the ammonia from the coal as a by-product.

The great industrial revolution which is imminent in the economical utilisation of blast-furnace gases is best shown by the careful calculations made by Prof. Richards of the results that would be attained by the application of this improvement to American blast-furnace practice. As an illustration of average practice, he takes the figures from a blast-furnace plant in Eastern Pennsylvania, which is making in three furnaces 2600 tons of pig iron per week. The composition of the gas by volume is as follows:—

CO_2	CO	H	N
9	27	1·8	62·8

The pig iron produced daily is 370 tons; the fuel used per 100 kilograms of pig iron, 100·0 kilograms; carbon in fuel, 82·9 kilograms: carbon in flux, 4·6 kilograms; carbon in the iron, 3·1 kilograms; efficiency of stoves, 60 per cent.; efficiency of boilers and engines, 4·5 per cent.; pressure of blast, 1·3 kilogrammes per square centimetre (20 lbs. per square inch); and temperature of blast 555° C.

With these conditions, the calculations are as follows:—

Calorific power of gas per cubic metre, 873 calories; volume of gas per 100 kilograms of pig iron, 434·7 cubic metres; calorific effect of gas per 100 kilogrammes of iron, 379,490 calories; heat required to heat blast per 100 kilograms of iron, 90,500 calories; indicated horse-power of engines for blast, 950 horse-power; indicated horse-power of engines for hoist, pumps, &c., per 100 tons of iron daily, 65 horse-power.

From these calculations the following conclusions are arrived at:—

		Calories.
Calorific effect of gases per 100 kg. of pig iron		379,490
Lost (10 per cent.)	37,950	
For heating blast	90,500	
		128,450
Surplus for burning develops ...		251,040
Surplus per 100 tons of pig iron daily		251,000,000

The horse-power at 100 per cent. efficiency would be 16,400; horse-power with steam at 4½ per cent. efficiency, 738; deficit of steam power per 100 tons of iron daily, 277 horse-power; horse-power with gas engines at 30 per cent. efficiency, 4920; surplus power with gas engines per 100 tons daily, 3900 horse-power; deficit of steam power per 370 tons daily, 1025 horse-power; surplus of gas engine power per 370 tons daily, 14,400 horse-power.

It is an actual fact that at the works considered by Prof. Richards the three blast furnaces are charged with 800 horse-power, furnished to them by the boiler plants fired by coal. It is also a fact that nearly 10,000 horse-power is raised for the rest of the plant by coal-fired boilers, and that all of this could be supplied by gas engines utilising the blast-furnace gases. The saving in the coal bill alone would amount to at least 30,000*l.* in one year. The gas-engine plant to accomplish this would cost 100,000*l.* These calculations, based on average practice, bring out very clearly the great saving of power possible by the economical utilisation of blast-furnace gases.

PRIZES PROPOSED BY THE PARIS ACADEMY OF SCIENCES FOR 1901.

THE following prizes are offered by the Paris Academy of Sciences for the year 1901:—

In Geometry, the Francœur Prize (1000 fr.), for discoveries or works useful to the progress of the mathematical sciences, pure or applied; the Poncelet Prize (2000 fr.), with similar conditions; and in Mechanics, the Extraordinary Prize of 6000 francs, for progress tending to increase the efficiency of the French naval forces; the Montyon Prize (700 fr.); the Plumey

Prize (2500 fr.), for improvements in steam engines or any other invention which contributes to the progress of steam navigation; and the Fourneyron Prize (500 fr.), for a theoretical or experimental study of steam turbines.

In Astronomy, the Lalande Prize (540 fr.), for the best work tending to the advancement of astronomy; the Valz Prize (460 fr.), for the most interesting observation during the current year. In Physics, a La Caze Prize (10,000 fr.); the Gaston Planté Prize (3000 fr.), for a discovery, invention or important work in the field of electricity; and the Kastner-Boursault Prize (2000 fr.), for the best work on the applications of electricity in the arts, industry and commerce. In Statistics, a Montyon Prize (500 fr.). In Chemistry, the Jecker Prize, and a La Caze Prize (each of 10,000 fr.), for researches in chemistry. In Mineralogy and Geology, the Delesse Prize (1400 fr.). In Physical Geography, the Gay Prize (2500 fr.), for a study of the distribution of alpine plants in the mountains of the Old World. In Botany, the Bordin Prize (3000 fr.), for a study of the influence of external conditions upon the protoplasm and nucleus in plants; the Desmazières Prize (1600 fr.), for a study of cryptogams; the Montagne Prizes (1000 fr. and 500 fr.), for researches on the anatomy, physiology, description, or development of the lower cryptogams; the Thoré Prize (200 fr.), for the best work on the cellular cryptogams of Europe; the De la Fons Melicocq Prize (900 fr.), for botanical work done in the north of France. In Anatomy and Zoology, the Grand Prize of the Physical Sciences (3000 fr.), for a biological study of the soft water Nematods; the Savigny Prize (1300 fr.), for the assistance of young travelling zoologists.

In Medicine and Surgery, a Montyon Prize; the Barbier Prize (2000 fr.), for a discovery in surgery, medicine or pharmacy of service in the art of healing; the Breant Prize (100,000 fr.), for a specific cure for Asiatic cholera; the Godard Prize (1000 fr.), for work on the anatomy, physiology and pathology of the genito-urinary organs; the Bellion Prize (1400 fr.); the Mège Prize; the Lallemand Prize (1800 fr.), for the encouragement of work on the nervous system; and the Baron Larrey Prize (1000 fr.), for the best work on military medicine, surgery or hygiene. In Physiology, the Pourat Prize (1400 fr.), for experimental work on the cooling due to muscular contraction; a Montyon Prize (750 fr.), and the Philipeaux Prize (890 fr.), for work in experimental physiology; and a La Caze Prize (10,000 fr.).

Among the general prizes offered are the Arago and Lavoisier Medals, the Montyon Prize for unhealthy trades, the Wilde Prize (4000 fr.), the Cahours Prize (3000 fr.), the Tchihatchef Prize (3000 fr.). for Asiatic exploration, the Petit d'Ormoy Prizes (10,000 fr. each), for work in the mathematical or physical sciences, the Leconte Prize (50,000 fr.), for a new and capital discovery in mathematics, physics, chemistry, natural history or medical science, the Jean Reynaud Prize (10,000 fr.), the Saintour Prize (3000 fr.), the Gegner Prize (3800 fr.), the Trémont Prize (1100 fr.), and the Laplace and Rivot Prizes.

Of these prizes, the Lalande, La Caze, Delesse, Desmazières, Leconte and Tchihatchef are expressly stated as being open without distinction of nationality.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. C. T. R. Wilson, F.R.S., Fellow of Sidney Sussex College, has been appointed University Lecturer in Experimental Physics, in succession to Prof. Wilberforce, now of Liverpool. The appointment of Mr. H. Herbert Smith as Gilbey Lecturer in Agriculture has been confirmed by the Senate.

The following awards in Natural Science have been made at the combined examination for entrance scholarships held by ten of the colleges in December, 1900:—

Clare College.—£60, Leather, Bridlington School; £50, Pears, Clifton College; £40, Byatt, Charterhouse; Johnson Exhibition, Jordan, Bedford School.

Trinity Hall.—£40, Hopkins, St. Paul's, and Potts, Kingswood School.

Trinity College.—£80, Chittock, Harrow; £75, Bulleid, Exeter School; £50, Bray, Harrow; Sizarship, Mottram, St. Olave's; £50, Darwin, Marlborough; £40, Browning, Westminster, Chase, Oundle School, and Hodgson, Bedford rammar School.

Pembroke College.—£40, Straus, Harrow.

Gonville and Caius College.—£60, Whitehead, Battersea Grammar School; £70 (Salomons Engineering Scholarship), Brinton, Cheltenhám College; £30, Coxon, Shrewsbury School.

King's College,—£80, Spens, Rugby.

Jesus College.—£60, Crawford, Nottingham High School.

Christ's College.—£60, Radice, Bedford Grammar School; £40, Bygrave, Giggleswick School; £30, Dobell, Cheltenham College.

St. John's College.—£60, McDonnell, St. Paul's; £40, Jolly, Framlingham School.

Emmanuel College.—£60, Taylor, King Edward's School, Birmingham; £40, Watkins, Shrewsbury School.

THE ninth jubilee of Glasgow University will be celebrated on June 12-14.

FOR many years a large proportion of the national food supply has been dependent on the preservation of meat and fruit in transport and storage by means of artificial cold, so that the subject of refrigeration is one of great and growing importance to the public. Within the last two years a more special interest has been exhibited in this and kindred subjects by the cheaper and more convenient production of liquid air, the proposed applications of it, and the remarkable scientific discoveries to which it has led. Those of the public who wish for authoritative guidance and clear ideas on the whole subject of refrigeration will shortly have an opportunity of obtaining them placed within their reach. The Technical Education Board of the London County Council, acting in conjunction with the Council of University College, London, have arranged for a series of lectures on the artificial production of cold to be delivered in the chemical theatre of the college in Gower Street by Dr. W. Hampson. The lectures will begin on January 18, at 5.30 p.m., and will be illustrated by experiments. Those who wish to attend, or to obtain a syllabus of the lectures, should apply to the secretary of the college. Young engineers, and others who are engaged in practical work in connection with refrigerating machinery or cold storage, and who have not had the advantage of a systematic training in the physical sciences, should find this a useful opportunity of learning to understand better the connection between their work and the scientific principles involved in it.

THE case of Regina *versus* Cockerton is likely to have a profound effect on our national education. As readers of NATURE may remember, a district auditor, dealing with the accounts of the London School Board, disallowed certain sums paid out of the rates for the teaching of science and art in elementary schools according to the rules of the South Kensington "Directory," as distinguished from those contained in the "Code" of the Education Department. These disallowances were brought before Mr. Justice Wills and Mr. Justice Kennedy in the Queen's Bench Division with a view to having them quashed. But the Court has upheld the view taken by the auditor. The London School Board has been non-suited all along the line. To quote Mr. Justice Wills: "It is not within the power of the Board to provide, at the expense of the ratepayers, science and art schools or classes in day schools; . . . science and art classes in evening continuation schools are as much beyond the scope of rate-aided education as in day schools; but that in both such educational work may be carried on by the School Board provided the whole of the funds required for it are furnished from sources other than contributions from the rates." There is little likelihood that the matter will be allowed to rest here; it is bound to go ultimately to the House of Lords. But, whatever may be found to be the present state of the law, one thing the case makes transparently clear, and that is the chaotic condition of English education. As the *Times* said the other day, "by showing up the existing confusion and to some extent aggravating it, the judgment may perhaps hasten some comprehensive scheme for classifying education in a rational way."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 13, 1900.—"Additional Notes on Boulders and other Rock Specimens from the Newlands Diamond Mines, Griqualand West." By Prof. T. G. Bonney, F.R.S.

Shortly before the outbreak of the war in South Africa, a parcel of specimens from the Newlands Mine, West Griqualand, was sent

to Mr. C. Trubenbach, managing director in London, who forwarded them to the author for examination. They consisted of (1) boulders, (2) the diamantiferous rock (blue ground), (3) country rock. (1) One angular specimen, a felsite or porphyrite, with fluxion structure, might be only a fragment of a dyke or a flow; the other eight were more or less water-worn. All were holocrystalline igneous rocks, two being saxonites, two varieties of lherzolite, with a few garnets, one an enstatite-eulysite, one an eclogite like those described last year, but without any diamonds, one a hornblendic gabbro, exhibiting an interesting micropegmatitic structure with felspar and pyroxene, and one a diorite. (2) The blue ground presented a general resemblance to that from the De Beers mines—the so-called kimberlite—but its matrix contained a much larger amount of a minute, secondary brown mica. This matrix had been analysed by Mr. C. James at University College, with the result that the CO_2 and H_2O only amounted to 13·55 per cent., the magnesia being 12·14, and the other constituents showing that serpentine could not, at most, form more than about 25 per cent. of the rock. This, then, was yet another proof that the so-called kimberlite could not be an altered peridotite, but was really, as the writer contended, a breccia of rather variable composition. No diamonds were observed this year in the boulders described, but Mr. Trubenbach had obtained another specimen of a pyrope enclosing a small but well-formed diamond. (3) The country-rock. Of this the writer had examined, among others, a variety called "bastard blue" by the miners, which had occurred above the ordinary "blue" and was supposed by them to be related to it. This, however, was not the case. It was a mudstone containing little pebbles of diabase and, more rarely, of a microgranite and a subcrystalline limestone. It was, however, interesting as showing the existence of basic igneous rocks of Triassic or pre-Triassic age. Besides that, and the additional evidence as to the nature of the blue ground, this investigation brought the number of species or strongly-marked varieties of holocrystalline rocks which occur as boulders more or less waterworn up to seven at the very least. The author was of opinion that the most enthusiastic advocate of concretionary action would now be obliged to admit that the specimens, two of which, described in his last paper, had contained diamonds, were rock fragments which had been shaped by the action of water.

Mathematical Society, December 13, 1900.—Dr. Hobson, F.R.S., President, in the chair.—Mr. Basset, F.R.S., spoke on the real points of inflexion of a curve.—Miss Barwell read a paper entitled, "On the conformal representation of polygons on a half plane."—Prof. Elliott, F.R.S., communicated his own paper, "The syzygetic theory of orthogonal Binariants," and gave an account of a paper by Mr. A. L. Dixon entitled "An addition theorem for hyperelliptic functions."—The following papers were communicated by their titles: On some properties of groups of odd order, ii., Prof. Burnside, F.R.S.—On discriminants and envelopes of surfaces, Mr. R. W. Hudson.—Note on the inflexions of curves with double points, Mr. H. W. Richmond.

Zoological Society, December 18, 1900.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—The Secretary exhibited, on behalf of Major A. St. Hill Gibbons, the skull and horns of a white rhinoceros (*Rhinoceros simus?*) from the White Nile, and the mounted heads of two species of Topi antelopes, which had been procured by Major Gibbons during his recent journey through Africa from south to north.—The Secretary also exhibited, on behalf of Sir Harry Johnston, K.C.B., some pieces of skin of an apparently new species of zebra which had been ascertained to inhabit the forest on the banks of the Semleki River near the borders of the Uganda Protectorate.—A communication was read from Capt. Stanley S. Flower, containing an account of the animals he had obtained or observed during Sir William Garstin's expedition to the White Nile. Amongst these were examples of several rare species of antelopes, such as the white-eared kob (*Cobus leucotis*) and Mrs. Gray's kob (*Cobus mariæ*), and numerous specimens of the shoe-bill or whale-headed stork (*Balaeniceps rex*).—A communication was also read from Mr. W. Malcolm Thomson containing an account of a large branchiate polynoid (*Lepidonotus giganteus* Kirk) from New Zealand.—A communication from Mr. H. M. Kyle (of St. Andrews, N.B.), contained a description of a new genus and species of flat-fishes from New Zealand, under the name *Apsetta thompsoni*.—Dr. A. G. Butler contributed a paper on the butterflies lately collected, and presented to the British Museum, by Lord Delamere. The specimens had been obtained chiefly near Mount Kenya, in British East Africa, and had been referred by the author to seventy-nine species, which were enumerated in the paper.—Prof. D'Arcy W. Thompson, C.B., exhibited and described a large specimen of a cuttle-fish (*Ancistroteuthis robusta* Steenstrup) from Unalaska. The generic position of this cuttle-fish had previously been uncertain, owing to the absence of knowledge of the tentacular club. This was now described for the first time, and confirmed Steenstrup's provisional identification.—Mr. F. E. Beddard, F.R.S., described a new species of earthworm under the name of *Amyntas alexandri*. The specimen had been sent to him from Kew Gardens, whither it had been imported from the neighbourhood of Calcutta.

PARIS.

Academy of Sciences, December 24, 1900.—M. Maurice Lévy in the chair.—Formulæ and tables for calculating the times and heights of high and low water, the heights from hour to hour being known, by M. E. Guyou. The heights for three consecutive hours being known, a very simple formula is given for calculating the time of high water.—On the origin of chemical combination and the combination of silver with oxygen, by M. Berthelot. Silver foil, heated with oxygen in sealed tubes at varying temperatures, is slightly attacked, some argentous oxide being formed and the silver becoming different in appearance. This action commences at a temperature of about 200° if the time of heating is very prolonged, and becomes very appreciable at 500°–550° C. If the oxygen is replaced by steam or carbon dioxide the silver is absolutely unchanged.—Silver and carbon monoxide, by M. Berthelot. Silver foil, after four hours heating with dry carbon monoxide at 500°–550°, becomes changed in appearance, and some three to four per cent. of the gas disappears, carbon being deposited and carbon dioxide produced.—Hydrogen and silver, by M. Berthelot. Hydrogen, heated with silver at 550° in a sealed tube, behaves differently from nitrogen, steam or carbon dioxide, as the metal alters considerably in appearance. It is possible that a compound is formed analogous to sodium hydride.—On the theorem of Hugoniot and some analogous theorems, by M. P. Duhem.—The first sign of life, by M. Augustus D. Waller. Following up some researches on the last sign of life, it results that if a *blaze* is the last sign it should also be the first. Some experiments with hens' eggs confirm this view.—On congruences of which the two focal pencils are cyclic, by M. C. Guichard.—The homographic compass, realising by articulations general plane homography, by M. G. Kœnigs.—On Neumann's method of the arithmetical mean, by M. W. Stekloff.—On a series relating to a theory of a linear differential equation of the second order, by M. A. Liapounoff.—On the theta functions of three variables, by M. M. Krause.—The theorem of vortices in thermodynamics, by M. Jougnet.—Permanent modifications of metallic wires and their electrical resistance, by M. H. Chevallier. The same wire is submitted to a series of heatings, which are alternately fixed and oscillating, and the variations of resistance measured. It was found that the permanent variations of resistance are greater when the temperature is oscillating than when it is fixed.—On the electromotive force of magnetisation, by M. René Paillot. It has been shown by M. Hurmuzescu that in a battery formed of two electrodes of iron, one of which is magnetised, the latter becomes positive with respect to the non-magnetised one. These experiments have now been extended to much stronger fields, 30,000 units, and it is found that for a given specimen of iron and acid the electromotive force of magnetisation tends always to a fixed limit.—The luminescence of a rarefied gas round metallic wires communicating with one of the poles of an induction coil, by M. J. Borgmann.—An apparatus allowing several physiological applications of the light produced by an incandescent lamp, by MM. Foveau de Courmelles and G. Trouvé. An application of parabolic mirrors.—On the liquefaction of gaseous mixtures. The isotherms of a mixture, by M. F. Caubet. A discussion of results obtained with mixtures of carbon dioxide and sulphurous acid, and of carbon dioxide with methyl chloride.—A contribution to the study of rarefied gases, by M. Albert Colson.—Influence of pressure on the phenomena of chemical equilibrium, by M. O. Boudouard. A description of some experiments upon the formation of carbon monoxide from carbon dioxide and charcoal.—On the selenides of copper, by M. Fonzes-Diacon. Some new methods of pre-

paring copper selenide, CuSe.—On some chlorobromides of thallium, by M. V. Thomas.—The action of reducing agents upon the two isomeric nitrodimethylacrylic esters, by MM. L. Bouveault and A. Wahl. Of the various substances tried, the only one giving a good yield of the corresponding amido-body was aluminium amalgam, several derivatives of which are described. —On tannase, by M. A. Fernbach. The tannase was prepared by the action of *Aspergillus Niger*, and then rendered sterile by filtration through porcelain.—Tannase, a diastase capable of hydrolysing gallotannic acid, by M. Henri Pottevin. —On the glycolysis of different sugars, by M. P. Portière. Of the sugars examined, the only ones which underwent glycolysis in the presence of the blood of the dog or the rabbit were galactose, lævulose and maltose.—Study of uranium nitrate, by M. Œchsner de Coninck. Densities of aqueous and alcoholic solutions of uranium nitrate, together with some solubilities in some other liquids.—Reaction of *p*-diazobenzene sulphonate of sodium upon the cystinate of iron existing in contaminated waters, by M. H. Causse. A reply to the criticisms of M. Molinié.—On the chemical transformations which take place during the evolution of the bud, by M. G. André. From the point of view of the distribution of the mineral material and organic substances, the evolution of the bud is comparable with the germination of the seed.—On some derivatives of methyl-nonyl-ketone, by M. H. Carette.—On the relations between the chemical constitution of the sexual products and that of solutions capable of determining parthenogenesis, by MM. Yves Delage and Marcel Delage. The theory advanced by Loeb as to the influence of magnesium salts in development requires a difference in the proportion of magnesium salts in the male and female. An experimental study shows that this is not the case, and hence that the proposed theory is inexact.—Germinative cells: male ovules and the cells of Sertoli, by M. Gustave Loisel.—On the signification of the basilar granulations of cilia, by M. P. Vignon.—The physiological relations of intermittent albuminuria, by M. A. Charrin.—Phagocytosis of the Eberth bacillus, by MM. O. F. Mayet and J. Bertrand. The authors have been able to clearly demonstrate the absorption of the Eberth bacillus by the white blood corpuscles.—Cytometric and caryometric researches on the motor nervous cells after the section of their cylindraxis, by M. G. Marinesco. —Remarks on the experiments of Mlle. Barthelet on telegony, by M. Édouard Rogez.—Remarks on the same subject, by M. Giard.—On the parasitism of *Fusarium roseum* and allied species, by M. Louis Mangin.—On the cytology of the Gastromycetes, by M. René Maire.—Variations of structure in a green algæ, *Stichococcus bacillaris*, under the influence of the medium, by MM. L. Matruchot and M. Molliard.—On the development of etiolated plants afterwards turned green by light, by M. H. Ricome.—Effects of annular decortication in some herbaceous plants, by M. Lucien Daniel.—On the age of the granitic *massif* of Cauterets and Néouvielle (High Pyrenees) and of part of the ancient neighbouring formations, by M. A. Bresson.—On the upper Cretacean at Mozambique, by M. Paul Choffat.—The ice caps of the Antarctic regions, by M. Henri Arctowski.—Barometer variations and the synodic revolution, by M. A. Poincaré.—Atmospheric electricity according to observations at the Eiffel Tower and at the central meteorological office, by M. A. B. Chauveau.—On the determination of the density of sea-water, by M. J. Thoulet.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 3.

RÖNTGEN SOCIETY, at 8.—Continental Progress in Practical Radiography and Apparatus: A. W. Isenthal.

FRIDAY, JANUARY 4.

GEOLOGISTS' ASSOCIATION, at 8.—The Geology of Swanage—Chapman's Pool to Punfield Cove (Kimeridge Clay to Upper Greensand): Horace W. Monckton.

MONDAY, JANUARY 7.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Early Manufacture of Sulphuric and Nitric Acids: Oscar Guttmann.—Note on the So-called "Heat Test" for Explosives: W. Cullen.

VICTORIA INSTITUTE, at 4.30.—Hornets: Rev. F. A. Walker.

TUESDAY, JANUARY 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Glasgow Bridge: B. H. Blyth. Railway Bridge over the Fitzroy River, at Rockhampton, Queensland: W. J. Doak.—The Niagara Falls and Clifton Steel Arch Bridge: L. L Buck.—Monthly Ballot for new members.

WEDNESDAY, JANUARY 9.

GEOLOGICAL SOCIETY, at 8.—The Geology of South-Central Ceylon: John Parkinson.—Note on the Occurrence of Corundum as a Contact-Mineral at Pont Paul, near Morlaix (Finistère): A. K. Coomára-Swámy.

THURSDAY, JANUARY 10.

MATHEMATICAL SOCIETY, at 5.30.—On the Singularities of Quartic Curves: A. B. Basset, F.R.S.—On Streaming Motions past Cylindrical Boundaries: Prof. Love, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Capacity in Alternate Current Working: W. M. Mordey.——*And, if time permit*: The Use of Aluminium as an Electrical Conductor, with New Observations upon the Durability of Aluminium and other Metals under Atmospheric Exposure: John B. C. Kershaw.

FRIDAY, JANUARY 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Geodesy: Wilfrid Airy.

CONTENTS.

THURSDAY, JANUARY 10, 1901.

THE SCIENCE OF ORE DEPOSITS.

Lehre von den Erzlagerstätten. By Dr. R. Beck. 1 Theil. Pp. iv + 384. (Berlin: Borntraeger, 1901.)

IN striking contrast to the almost universal neglect with which the subject of ore deposits is treated in this country is the increasing attention that it is receiving from geologists and mining engineers abroad, and more especially in Germany and in the United States. In the recently published annual general report and statistics of the output of minerals in Great Britain, by Dr. C. Le Neve Foster, attention is called to the fact that our production of all metalliferous minerals, already small, is continually shrinking, and whilst this unpleasant fact may be the cause of the above-noted neglect of the study of ore deposits, it may equally well be an effect thereof, and may present one more example of the way in which we are being left behind by other nations in industrial pursuits, merely because we so uniformly disdain to study their scientific aspects.

The work now under review serves well to emphasise the difference between the treatment of scientific technology in the two countries; it is written by the professor of geology and of the science of mineral deposits at the ancient and famous Royal Mining School of Freiberg. In this country we have no ancient mining schools—perhaps even no mining schools at all, as the Germans understand this term—and not a single professorship devoted to the study of mineral deposits.

This latter subject has nowhere been the subject of more assiduous study than it has at Freiberg, and this fact alone would make the present treatise one of exceptional importance. Its author is, moreover, a recognised authority on the theory of ore deposits, and his work is marked with decided originality in many respects. The only difficulty in forming a fair estimate of it lies in the fact that the volume before us is only half a book, concluding abruptly in the middle of a chapter. It seems that the remainder is not to be published till next year, and as the present part does not include any table of contents it is impossible to say now what the scope of the completed work will be. It is hard to see what good end is to be served by this fragmental system of publication.

The most interesting point about any work on ore deposits is the system of classification and arrangement adopted in it. Dr. Beck commences his work by a division of all deposits into two main groups, (1) Primary, and (2) Secondary, the latter group including the deposits formed by the destruction of pre-existing ones, whether as alluvial deposits or by disintegration *in situ*. It is obvious that such a division is defective in many respects, apart from the fact that the two groups thus formed are of very unequal importance. In the first place it is impossible in many cases to predicate with certainty of an ancient deposit that it was primary in its origin, seeing that all traces of its original genesis may have been lost owing to wide-reaching metamorphism; and, again, there is no real genetic difference between a recent mineral deposit and an ancient one, and it is illogical to base the first great classificatory grouping upon a distinction of such little real importance. Worst of all, the author finds himself unable to maintain his own classificatory system. A striking example of this defect is his inclusion amongst the primary deposits of "bedded gold deposits of Palæozoic and Mesozoic age," the first example of which, given by him, is certainly an alluvial deposit of Cambrian age, whilst all the others were probably also alluvial deposits. Dr. Beck's inclusion of Tertiary and more recent alluvial deposits in his secondary group, whilst all alluvials older than Tertiary are included among primary deposits, is as arbitrary as it is unpractical, and, moreover, is in no way justified by his own definitions.

The group of primary deposits is here further divided into (*a*) *Syngenetic*, or such as were formed contemporaneously with the surrounding rocks, and (*b*) *Epigenetic*, or such as were formed subsequently; the first class is again subdivided into (1) Magmatic segregations, and (2) Stratified ore deposits, and the second class into (1) Fissure veins, and (2) Deposits that are not vein-like; the latter class is again further subdivided, but the deposits included in it are not covered by the present volume, so that their discussion must be deferred. Perhaps the least satisfactory group of the present classification is the first subclass of magmatic segregations, which is intended to cover ore deposits produced by magmatic differentiation from molten eruptive rocks. We doubt whether many geologists would even endorse fully the opening sentence of this section: "The origin of metals is, without doubt, the inaccessible interior of the earth's crust," more especially seeing that the main argument in support of this very dogmatic statement is based upon the high specific gravity of the earth as a whole, compared with that of the rocks composing its surface. This subclass is divided into three sections, namely, segregations of native metals, of oxidised ores and of sulphuretted ores respectively. The first section is especially unfortunate; the first examples quoted, namely, native iron in the island of Disko, nickeliferous iron at Awarua, New Zealand, and platinum in the Urals, are none of them mineral deposits in the sense in which Dr. Beck, quite correctly, defines the word, namely, deposits of mineral of economic importance; further, the last example, namely, the occurrence of native copper in the melaphyres of Lake Superior, is certainly not a case of magmatic segregation, but is a well-marked instance of an epigenetic deposit; and the only other example, that of the occurrence of gold in certain eruptive rocks, is in many cases neither of economic importance nor of indisputably magmatic origin. The next section, that of the oxidised ores, is more satisfactory in many respects, although doubts may well be entertained of the soundness of any system of classification that separates, as widely as Dr. Beck does, the iron ore deposits of Kirunavaara and Luossavaara from those of Gellivaara and Svappavaara, all four of which show very many and very interesting points of similarity. The third section, that of sulphuretted ores, is again open to doubt, and it seems as though more stress had been laid upon the accidental circumstance, whether a given deposit lies wholly within or merely in proximity to an igneous outburst with which it is probably genetically connected,

than upon the real genetic and morphological relations of the deposit. Hence it is that Dr. Beck places the pyritic deposits of Rio Tinto, Mount Lyell, &c., in quite a different group from those of Sudbury, although most authorities prefer to group them together. Moreover, it is only in very few of the examples cited under this head that the magmatic origin of the deposit can be said to be in any degree probable.

The class of the stratified ore deposits is better defined, although it would have been preferable to have either excluded altogether deposits that consist of ores disseminated through an otherwise barren bed, or else to have included all forms of this mode of occurrence; the attempt to class impregnations amongst the epigenetic deposits, and to include in the present class only such disseminations as were formed contemporaneously with the bed in which they occur, is necessarily unsatisfactory, for there are very few instances in which the true mode of origin of such deposit has been proved beyond the possibility of dissent. Another source of weakness in this classification is the inclusion here of typically lenticular deposits, whenever the lens lies parallel to the stratification. Here again a relatively accidental character has been emphasised whilst the real geological relations of the deposit have been lost sight of.

Dr. Beck is perhaps at his best in his classification of veins, although the method here adopted is purely empirical. Such important geological relations as those of the vein to the country rock are utterly disregarded, contact veins are not distinguished from true fissure veins, &c., whilst the classification relies entirely upon the mineralogical character of the vein filling. This is the old Freiberg classification, revised and extended, and though it is less satisfactory when applied to the world as a whole than it was when restricted to the Freiberg district, it is nevertheless interesting, and, to a certain degree, even useful. By far the worst portion, and the only one that is wholly unsatisfactory, is the attempt to classify the gold-bearing veins, the distinctions here drawn being far too artificial, and the lines of demarcation too imaginary.

It may be noted, by the way, that the well-known Sheba deposit is here classed as a vein, whilst the bulk of what is known about it tends to show that it is certainly a bed. It is also doubtful whether the majority of the cinnabar deposits are really veins, as they are here designated.

In pointing out that many and grave faults can be found with Dr. Beck's classification of ore deposits, nothing more is intended to be conveyed than that Dr. Beck has not succeeded where every one else has failed. It may be doubted whether any one has yet evolved a classification of ore deposits that satisfied anybody—even its author; the inherent difficulties of the subject are so great and so manifold that a satisfactory solution of the problem may, in the present state of the science, fairly be declared to be impossible. Classification apart, Dr. Beck's work forms a contribution of the utmost value to the study of ore deposits; his descriptions are concise and clear, and his illustrations are well selected, especially as regards German, Austrian and Scandinavian deposits. The section on faults is eminently satisfactory, and indeed it would be hard to point to any work in which this complicated portion of the subject has received better treatment. It is difficult to pass judgment on half a book, but it may fairly be said that if the remainder of the work is only equal to the first half, it will constitute one of the best works available on the subject of ore deposits, provided that it is furnished with thoroughly complete indexes, and not with the apology for an index that usually does duty in German works. As the ore deposits described are arranged in accordance with the author's own system of classification, a complete alphabetical subject-index, together with a complete alphabetical index of geographical names, are needed to make Dr. Beck's work the highly useful book of reference that its other merits entitle it to become.

H. LOUIS.

THE THEORY OF "SCREWS."

A Treatise on the Theory of Screws. By Sir Robert Stawell Ball, LL.D., F.R.S. Pp. xix + 544. (Cambridge University Press, 1900.)

SIR ROBERT BALL'S "Theory of Screws" is one of the most notable modern extensions of theoretical dynamics. It is based on Poinsot's discovery that every set of forces, regarded as acting on a rigid body, is reducible to a force along one definite line and a couple round the line; combined with Chasles's discovery that every instantaneous motion of a rigid body is reducible to rotation round one definite line and translation along it—in other words to a screwing motion. The modes of reduction in the two cases are strictly analogous; a force along a line being the analogue of a rotation round the line, and translation in any direction being the analogue of a couple whose axis has this direction.

The theory of screws treats of these two subjects in conjunction. The definite line along which the force acts, or round which the body rotates, is regarded as the *axis* of a *screw*, and the ratio of the couple to the force in the one case, or of the translation to the rotation in the other, is called the *pitch* of the screw. The sign of the pitch indicates whether the screw is right-handed or left-handed, and is not altered by reversing the screw end for end.

It would be convenient to have some general name for anything which follows the laws of combination employed in these reductions. Clifford called it a *motor*. It might well be called a *screw-actor*. The resultant of two screw-actors may be called their *sum*.

When the screw-actor is a set of forces, Sir R. Ball calls it a *wrench*—a name which is not suggestive of a statical concept, but rather of force combined with motion. The name *forcive* seems more appropriate.

When the actor is a screw motion, Sir R. Ball calls it a *twist*, and the name *twist-velocity* is given to a screw-velocity. The twists considered in the theory of screws are, in general, supposed to be so small as to admit of simple superposition, quantities of the second order being negligible.

Five numbers are required for specifying a screw. Two will give the direction of the axis, two the intersection of the axis with a fixed plane, and one the pitch. From another point of view a screw is defined by the five ratios of the six components of a screw-actor.

The theory of screws lends itself with special readiness to the discussion of the movements of a body with a given number of degrees of freedom. A body with one degree

of freedom can only move on one definite screw. A body with two degrees of freedom can take two independent screw motions combined in any ratio. This gives an infinite number of resultant screws, all lying in one ruled surface (called a *cylindroid*) and having pitches distributed according to a simple law. All cylindroids have the same shape, and the linear dimensions of a cylindroid are proportional to the difference between the greatest and least pitch that can be found among its screws. A body with n degrees of freedom has n independent screw motions, n being not greater than 6.

Any screw system which specifies the freedom of a body serves equally well for specifying aggregates of screw-actors of the forcive kind. For instance, if any multiple (integral or fractional) of a forcive on a screw A is compounded (additively or subtractively) with a forcive on a screw B, the resulting forcive will be on one of the screws of the cylindroid to which A and B belong.

A body limited to motion on one definite screw can move in either of two opposite directions, and when acted upon by a forcive will move in the direction for which the work done by the forcive is positive. When the forcive-screw is so related to the motion-screw that the work-rate for a small motion is zero, the body will be in equilibrium, the forcive being equilibrated by the reaction of the constraints. The two screws in this case are said to be *reciprocal*. The condition of reciprocity, when expressed in terms of the rectangular components X Y Z of force, $u\ v\ w$ of translation, L M N of couple, and $p\ q\ r$ of rotation, is

$$Xu+Yv+Zw+Lp+Mq+Nr=0;$$

and this will not be altered by interchanging the force X with the rotation p, the couple L with the translation u, and so on. Hence it is immaterial which of the two screws we assign to the forcive and which to the motion.

One degree of constraint subjects the 6 components, $u\ v\ w\ p\ q\ r$, of an instantaneous motion to one linear relation. It can accordingly be expressed by assigning proper values to the coefficients X Y Z L M N in the above equation of condition. One degree of constraint, therefore, limits the motion of a body to those screws which are reciprocal to one definite screw. Hence it can be deduced that two degrees of constraint limit the motion to screws reciprocal to all the screws of one definite cylindroid.

The system of screws on which a body can move which has n degrees of freedom or $6-n$ degrees of constraint being called an *n system*, it can be shown that every n system is reciprocal to a definite $6-n$ system. Each of these two systems is sufficient to define the other.

In a 5 system the axes of the screws include every line in space, each fitted with its proper pitch, and at every point there are a whole plane of screws of any assigned pitch.

Three or more screws are said to be independent when it is not possible to take screw-actors upon them whose sum is zero. Seven screws cannot be independent. If any 6 independent screws are taken, they will suffice for the specification of any 7th screw by 6 numerical coefficients, called *screw-coordinates*, an actor on the 7th screw being always a sum of multiples (generally fractional) of actors on the 6 screws of reference. It is possible, and usually preferable, to select screws of reference such that each is reciprocal to all the rest.

If a body is only free to move on a single screw, a forcive applied to it can be resolved into two forcives, one of which is reciprocal to the screw in question. This component can be ignored, as it does not influence the motion, which will accordingly be the same as if the other screw acted alone. If a body has n degrees of freedom, a forcive applied to it can be resolved into 6 mutually reciprocal forcives of which $6-n$ are without influence on the motion, and the other n may be regarded as acting alone.

The initial motion of a body produced by an impulsive forcive is, in general, on a different screw from the forcive; but in certain cases they are on the same screw. (This means that they have the same axis, and the work in translation is equal to the work in rotation). The screw, common to both, is then called a *principal screw of inertia*. There are, in general, 6 such screws for a perfectly free body, and n for a body with n degrees of freedom.

Again, for a body in stable equilibrium under forces which have a potential, there are certain screws (generally equal in number to the degrees of freedom) such that if the body be slightly displaced along one of these screws, and then left to itself either at rest or with a velocity on the same screw, it will oscillate on this screw. The screws thus defined are called *harmonic*, and are the proper screws to select for specifying small oscillations.

Besides physical deductions, of which the foregoing are specimens, the treatise contains numerous geometrical investigations, and an extension of the theory to non-Euclidian space.

At the end of the volume an interesting summary is given of the literature of the subject. It appears that Hamilton, in one of his papers on systems of rays, and Plücker, in his *New Geometry of Space*, anticipated Sir R. Ball's discovery of the cylindroid so far as regards its geometrical form without reference to pitch; and several theorems respecting systems of lines had been discovered which are particular cases of the general theory of screws.

An amusing and instructive "Dynamical Parable," which formed Sir R. Ball's Presidential Address to Section A at the 1887 meeting of the British Association, is given as an Appendix.

I wish to point out an erroneous statement with regard to finite displacements which occurs in all our works of highest authority on the motion of a rigid body. It is to be found in *Routh*, in *Thomson and Tait*, in *Williamson and Tarleton*, and in the introduction to Sir R. Ball's *Treatise*. The erroneous statement, in its plainest shape, is "The same displacement cannot be constructed on two different screws."

To see that this is wrong, consider the effect of giving a nut $9\frac{1}{4}$ turns on an ordinary iron screw. The same final position could obviously be attained by employing a screw of longer pitch and taking fewer turns, say $8\frac{1}{4}$ or $1\frac{1}{4}$ or $\frac{1}{4}$, and could also be attained by taking $\frac{3}{4}$ or $1\frac{3}{4}$ or $8\frac{3}{4}$ turns on a left-handed screw. The correct statement is that the axis and translation are unique, but that the rotation has any one of an indefinite number of values differing each from the next by 2π, some of them being

positive (right-handed) and some negative (left-handed). If l is the translation, and p_0 one value of the pitch p, the general value of p is given by

$$\frac{1}{p}=\frac{1}{p_0}\pm\frac{2n\pi}{l}.$$

J. D. EVERETT.

CULTIVATION AND MANUFACTURE OF TOBACCO.

Le Tabac Culture et Industrie. By E. Bouant. Pp. xii+347. (Encyclopédie Industrielle, Paris: J. B. Baillière et fils, 1901.)

THE object of this work, as stated by the author in the preface, is to describe in popular scientific language the long series of operations necessary to transform a tiny seed into a good cigar or a pinch of scented snuff.

In a short introduction the author gives a *résumé* of the best ascertained facts concerning the origin of tobacco, its introduction into Europe, the prohibitions intended to hinder its use, and the change of tactics which have resulted in making the smoker contribute his quota to the public revenue.

Of the three parts into which the book is divided, the first two deal with the cultivation and manufacture of tobacco, and in the third part the economic, fiscal and hygienic aspects of tobacco are discussed.

In France the State controls the cultivation, and has the monopoly of the manufacture of tobacco; the author restricts his treatment of the subject almost entirely to a description of the methods of culture and manufacture followed in France.

Part i. commences with the botany of the principal species of Nicotiana and with a short account of the chemistry of tobacco. According to the analyses given on p. 24, tobacco ash contains a large proportion of salts of sodium (16 per cent. in the ash from the leaves of Havana tobacco). This is at variance with the general experience, for it is a remarkable and well-established fact that tobacco contains very little soda in any form.

The subject of culture is dealt with very fully, and a large amount of information is given concerning the choice of the most favourable soils and manures, the rotation of crops, sowing and transplanting, the various field operations during growth and ripening, and the final operations of harvesting, curing and packing.

In view of the experimental cultivation of tobacco which has been carried on in Ireland during the past season, it is interesting to note that the experience gained in France shows that Europe will never be able to dispense with American tobacco, as, with rare exceptions, European varieties are inferior in aroma and combustibility to those of American origin.

The manufacturing methods described in the second part are those employed in the great State tobacco factories of France. The methods of manufacturing cut and roll tobacco and snuff differ materially from those followed by British manufacturers, the result, no doubt, of the different fiscal regulations in the respective countries. The methods employed for making cigars and cigarettes, on the whole, are the same in both countries.

The book is well illustrated and, with the exception of a few photographic reproductions which leave much room for improvement, the illustrative figures are good and clear; typographical errors are not numerous. Altogether it is a very readable work, and, in addition to being interesting to the general reader, it should be of some service to those engaged in the cultivation and manufacture of "our holy herb Nicotian." J. W.

OUR BOOK SHELF.

Briefwechsel zwischen Franz Unger und Stephan Endlicher. Herausgegeben und Erlaütert von G. Haberlandt. Pp. v. + 184. (Berlin: Borntraeger, 1899.)

AFTER the death of Unger's surviving son and daughter, a large portion of his correspondence was presented to the Botanical Institute of the University of Graz. From amongst these remains Prof. Haberlandt gives to the world the almost complete series of letters which passed between Unger and Endlicher from 1829 to 1847. There are 139 letters in all, of which about two-thirds are by Unger. Though the correspondence is, in large part, concerned with their own botanical labours, all the more important contemporary contributions to Botany are discussed between the friends. At the date of the opening of this correspondence, neither of the writers held an independent botanical post. Unger, who had deserted the law and qualified in medicine, in 1830 became a medical officer at Kitzbühel, in the northern Tyrol. Here, during his five years' sojourn, he collected the material for and wrote his now classic "Einfluss des Bodens auf die Vertheilung der Gewächse." This was the first attempt at a physiological flora, and Unger was justly proud of his achievement. This and other work paved the way to the professorship at Graz, to which he was appointed in the autumn of 1835, and which he held till Endlicher's death. Endlicher, the author of the well-known "Genera Plantarum," was made keeper of the botanical department in the Hof Museum, at Vienna, within a few months of Unger's appointment to Graz. Many common undertakings were mooted between the friends, and the most notable of those which reached accomplishment was their joint "Lehrbuch der allgemeinen Botanik," published in 1843. Its inception and progress are very fully set forth in the letters, and this portion of the correspondence will be read with interest as effectively contrasting the character and temperament of these two men. That Schleiden should have chosen the same time to bring out his remarkable "Grundzüge der wissenschaftlichen Botanik" was an event which could not fail to impress the joint authors. Unger, with characteristic outspokenness, writes :—"What do I think about Schleiden? He is an excellent fellow, though I don't agree with him entirely. We have wanted a man like this for a long time. It is by him—not by us—that a new epoch is created in our science." Another part of the correspondence, that relating to Unger's discovery of the ciliated zoospores of *Vaucheria*, is also full of interest. The headstrong and enthusiastic Unger insists on announcing his discovery in the form of a series of popular letters under the title "The Plant at the Moment of becoming an Animal," with an absurd quotation from Oken (the nature-philosopher) as motto. This intention draws from Endlicher one of the best letters in the book (No. 100); but it is quite lost upon Unger.

The correspondence is preceded by an able appreciation of the two botanists by Prof. Haberlandt, the present occupant of Unger's chair at Graz; whilst, by way of conclusion, there is printed a series of documents which tends to show that Endlicher died a natural death and did not commit suicide, as has been generally believed.

The British Journal Photographic Almanac, 1901. Edited by Thomas Bedding. Pp. 1552. (London: Henry Greenwood and Co., 1900).

THE fourth annual issue of this photographic almanac seems to be as popular as ever, judging by the great amount of matter contained in the present volume There are no less than 1552 pages, about 500 of which form the text. The arrangement of the book is the same as that adopted last year. There are over eighty articles on practical subjects, written by photographers, and these contain many useful hints which should be of service to those who utilise the experience of others. The "epitome of progress of the year," compiled by the editor, is very interesting reading, references to the most important advances being liberally made. "Recent novelties in apparatus" and "practical notes and suggestions of the year" also form no inconsiderable portion of the volume. The great collection of formulæ, tables, measures, photographic societies of the United Kingdom, &c., makes the volume a necessary accessory to any photographic studio.

Among the mass of material will be found some excellent illustrations, the frontispiece being a bromide print by Messrs. Morgan and Kidd. Not the least useful portion of this volume is the great collection of advertisements of most of the photographic manufacturers and dealers. The volume is quite up to, if it does not exceed, the standard of last year, and should be in the possession of all photographers. The price of one shilling brings it within the reach of all.

The Lead Storage Battery. By Desmond G. Fitz-Gerald. Pp. xi + 383. (London: Biggs and Co., no date.)

IN spite of the great industrial application of the accumulator, the theory of its working is in a very unsatisfactory state; and, moreover, those who desire to obtain information on the subject are obliged to seek for it in the publications of scientific institutions. Mr. Fitz-Gerald's book is a very useful summary of the leading facts and theories of the subject. Whilst fulfilling in some respects the objects of a text-book, it is much more than a text-book. Mr. Fitz-Gerald is able to speak with authority on both the chemical and electrical aspects of the storage cell, and his criticisms of existing types and suggestions of possible improvements will be found in many cases very valuable indications of what are likely to prove profitable lines of research. At the same time the book should be in the hands of any one who has to deal with accumulators, especially electrical engineers, who too often are quite ignorant of the chemistry of the subject. Besides discussing the various theories of the accumulator, the author gives an interesting account of its development, and descriptions, which are, we are inclined to think, too brief, of the different types of cell in use.

Mr. Fitz-Gerald apologises in the preface to the book for its possessing the defects of a compilation from notes made from time to time. It would have been better if, instead of making this apology, the author had removed the defects and had made the book a more consecutive work. It is difficult to make out to whom the book is intended to appeal, as in some instances elaborate calculations are entered into on points so elementary as to be quite childish, whilst in others a knowledge of chemistry is assumed which we doubt if the average electro-chemist possesses and feel sure is not possessed by the majority of electricians. In addition, the parts devoted to the history and theory of the subject respectively are intermixed without any apparent reason, and lose greatly in continuity and clearness in consequence. These defects are the more to be deplored as it is to be feared that they will discourage many from reading the book.

The Elements of Inorganic Chemistry. For Use in Schools and Colleges. By W. A. Shenstone, F.R.S. Pp. xii + 506. (London: Edward Arnold, 1900.)

THE object of the author of this elementary text-book is clearly stated in his preface. He says:—

"I have endeavoured to provide a book which begins with a course of experimental work for quite young students, and develops at the later stages into a text-book suitable for those who are older—that is, into a text-book containing fewer facts than those written solely for senior students, and in which the powers of young workers are more carefully kept in view in the earlier and middle parts than is necessary in the case of books written for students of a different type."

The book is divided into five parts. Part i. is chiefly taken up with the study of water and air, as exemplifying some of the principal types of chemical action and physical properties; Part ii. treats of the laws of combination and the atomic theory; Part iii. of the non-metals and their principal compounds; Part iv. of chemical affinity, heat changes, electrolysis, spectrum analysis and crystallography; Part v. of the metals and their chief compounds.

Directions are given for the performance of several hundreds of experiments, most of which can be done by the student himself. These directions, like the diagrams of apparatus which illustrate them, are very simple and clear.

The book seems extremely well adapted to the wants of the class of students the author has in view. Any youth of ordinary intelligence who works through the volume under the supervision of a competent demonstrator will acquire, not only an adequate knowledge of the facts of chemistry, but also sufficient theory to enable him to range and systematise these facts and to understand their general bearing.

The Thompson-Yates Laboratories Report. Edited by Profs. R. Boyce and C. S. Sherrington. Vol. i., Reprints, 1898–99; Vol. ii., Reprints and Reports, 1898–99; Vol. iii., Part 1, 1900. (Liverpool: University Press.)

THESE three handsome volumes testify to the energy and vitality of the Liverpool school. After a preliminary account of the laboratories founded by the munificence of the Rev. Thompson-Yates, vol. i. is devoted to neurology, and contains papers and reprints by Profs. Sherrington and Boyce, and Drs. Warrington, Laslett and Grünbaum, of which the one by the first-named author, upon the peripheral distribution of some spinal nerves, forms the *pièce de resistance*, occupying more than half the book. There are also interesting papers upon the changes found in lead paralysis and upon the muscle-spindles in pseudo-hypertrophic paralysis. In the latter, Grünbaum considers that his observations support the theory that this disease is a primary one of the muscles.

The first half of vol. ii. contains papers and reprints in bacteriology, hygiene and morbid anatomy, of which Dr. Balfour Stewart contributes three on plague—its diagnosis, and on the active constituents of Haffkine's prophylactic, Dr. Annett an interesting *résumé* of the tubercle-like bacilli in butter, and the same author an experimental inquiry on the use of boric acid and formaline as milk preservatives, in which he shows that kittens fed on milk containing these two substances are injuriously affected. The account of the morbid anatomy and pathology of a case of myelopathic albumosuria, by Drs. Bradshaw and Warrington, is a valuable contribution to our knowledge of this very rare disease, which was first described by Bence Jones, and of which only seven other cases have been recorded. Next follow the reports of the various departments and, as a supplement, Profs. Boyce and Herdman's report on oysters and disease, and the report of the Malarial Expedition to West Africa.

Vol. iii. is similarly mainly bacteriological. Balfour Stewart shows the wide distribution of the *Bacillus enteritidis sporogenes* of Klein, MacConkey contributes a paper on the differentiation and isolation of the *Bacillus coli* and *Bacillus typhosus* from mixtures by means of media containing bile salts.

The printing, illustrations and general "get-up" of the volumes are excellent. There is, perhaps, a tendency to needless detail in some places, as, for example, in the list of milk samples, but many of the papers are contributions of real scientific value.

Einführung in die Stöchiometrie. Von Joachim Biehringer. Pp. xviii + 498. (Brunswick: F. Vieweg und Sohn, 1900.)

THIS book, which differs greatly from the ordinary text-books of chemistry, has for sub-title "A study of the quantitative composition of substances and the properties connected therewith." So far as subject-matter is concerned, it covers much the same ground as Part i. of Ostwald's *Allgemeine Chemie*, the general arrangement evidently being inspired by that work. The treatment, however, is radically different, theoretical matters, although adequately outlined, being made subservient to their practical applications, which are illustrated by a wealth of numerical examples. The arithmetical exercises are, in fact, the chief feature of the book. There are altogether three hundred of them, each of which is provided with a fully-worked solution, the method of calculation being carefully explained. The problems are well-selected, unpedantic, and of real value in their application to laboratory or technical work. Some are, perhaps, a little far-fetched, but even these are instructive, and almost always possess some human interest. For example: "It is desired to convert into sparkling wine 1000 litres of new wine containing 10 per cent. by volume of alcohol and 0·5 per cent. of unfermented sugar. How much cane-sugar must be added in order that after fermentation the wine may have a pressure of 5 atmospheres, the temperature of the cellar being 12°?" The student will be especially grateful for the numerous examples of the calculation of molecular weights, and of the results of analysis, both gravimetric and volumetric. Altogether no better guide could be desired to chemical and elementary physico-chemical calculations.

Travail des Metaux dérivés du Fer. Par L. Gages, Capitaine d'Artillerie. "Encyclopédie Scientifique des Aide-Memoire." Pp. 202; 40 illustrations. (Paris: Gauthier-Villars, 1900.) Price 2 fr. 50 centimes.

THIS new member of the excellent *aide-memoire* series worthily upholds the reputation built up by its predecessors. It gives in clear, terse language a short summary of the mechanical and thermal treatment to which steel is subjected to prepare it for use in the industries, and the greater part of the remainder of the book is given up to considerations of the theory of hardening and tempering. The solution theory of the constitution of steel is so firmly established in France that it is now taken as an authoritative explanation of the facts; but some of the thermal and micrographic evidence is given, on which the theory is based. In dealing with "steels" which owe their distinctive properties to the admixture with iron of elements other than carbon, Captain Gages makes a new departure in classifying them in accordance with a law enunciated by Sir William Roberts-Austen, which sets forth the fact that elements having a lower atomic volume than iron tend to harden steel, and those with a higher atomic volume to soften it and make it malleable. This classification of a large class of materials which are comparatively new to engineers seems useful and businesslike, and, indeed, Captain Gages, by bringing into a brief and readable form the results of the labours of Osmond, Werth and many others, has done much to popularise the whole subject.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Stability of a Swarm of Meteorites.

REFERRING to my paper in NATURE of October 11, "On the Stability of a Swarm of Meteorites, &c.," Mr. R. B. Hayward, F.R.S., has called my attention to the fact that the supposition, made near the foot of the first column, that

$$\xi = a\cos\omega t,\ \eta = b\sin\omega t,$$

in other words that the relative orbit of the particle under consideration is an ellipse of semi-axes a, b, involves an eccentricity,

$$\sqrt{1-b^2/a^2},$$

for that ellipse of amount

$$n\sqrt{3/(\mu-\omega^2)} = \sqrt{6n/(\sqrt{n^2+16\mu}-n)},$$

so that in strictness the relative orbit cannot be a circle unless $n=0$.

This point ought, perhaps, to have been brought out in my paper as illustrating the rudeness of the approximation of the shape of the swarm to a sphere in any actual case, a matter which I touched on in speaking of the inutility of further refinements, such as the effect of the ellipticity of the swarm's orbit round the sun. However, for any probable swarm in the solar system, n^2/μ must be a very small fraction, and so ω^2 may be very nearly equal to μ (if the centre of the swarm is fixed, $\mu=\omega^2$), while b/a is nearly unity.

Mr. Hayward suggests that the same difficulty may have been felt by others, and that therefore the above explanation may be desirable. ANDREW GRAY.

The University, Glasgow, December 29, 1900.

An Artificial Representation of a Total Solar Eclipse.

IN preparing for polarisation experiments on the solar corona, it is extremely desirable to have an artificial corona as nearly as possible resembling the reality for preliminary work. The only device of the kind that has been used to my knowledge was the arrangement described by Wright in his eclipse report, consisting of a cardboard funnel, lined with black cloth, with a light at the back. This gives a ring-shaped illuminated area radially polarised. It is believed that the contrivance about to be described will be found far better adapted to work of this sort, for the artificial corona in this case resembles the real so closely as to startle one who has actually witnessed a total solar eclipse. The polarisation is radial, and is produced in the same way as in the sun's surroundings, and the misty gradations of brilliancy are present as well. So perfect was the representation that I added several features of purely æsthetic nature to heighten the effect, and finally succeeded in getting a reproduction of a solar eclipse which could hardly be distinguished from the reality, except that the polar streamers are straight, as drawn by Trouvelot, instead of being curved, as all the recent photographs show them. The curious greenish-blue colour of the sky, and the peculiar pearly lustre and misty appearance are faithfully reproduced. For lecture purposes an artificial eclipse of this sort would be admirably adapted, and I know of no other way in which an audience could be given so vivid an idea of the beauty of the phenomenon. Drawings and photographs are wholly inadequate in giving any notion of the actual appearance of the sun's surroundings, and I feel sure that any one will feel amply repaid for the small amount of trouble necessary in fitting up the arrangement which I shall describe.

A rectangular glass tank about a foot square on the front and five or six inches wide, and a six candle-power incandescent lamp are all that are necessary. The dimensions of the tank are not of much importance, a small aquarium being admirably adapted to the purpose. The tank should be nearly filled with clean water, and a spoonful or two of an alcoholic solution of mastic added. The mastic is at once thrown down as an exceedingly fine precipitate, giving the water a milky appearance. The wires leading to the lamp should be passed through a short glass tube, and the lamp fastened to the end of the tube with sealing wax, taking care to make a tight joint to prevent

the water from entering the tube (Fig. 1). Five or six strips of tinfoil are now fastened with shellac along the sides of the lamp, leaving a space of from ½ to 1 mm. between them. The strips should be of about the same width as the clear spaces. They

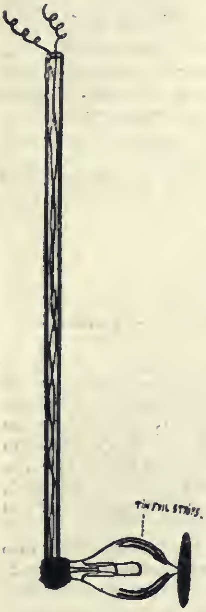


FIG. 1.

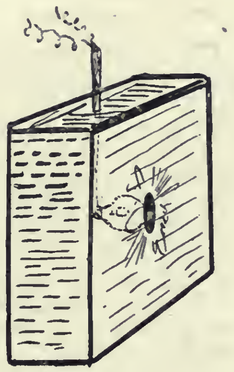


FIG. 2.

are to be mounted in two groups on opposite sides of the lamp, and the rays passing between them produce the polar streamers. The proper number, width and distribution of the strips

FIG. 3.

necessary to produce the most realistic effect can be easily determined by experiment. A circular disc of metal a trifle larger than the lamp should be fastened to the tip of the lamp with sealing-wax, or any soft, water-resisting cement; this cuts off the direct light of the lamp and represents the dark disc of the moon. The whole is to be immersed in the tank, with the lamp in a horizontal position and the metal disc close against the front glass plate (Fig. 2). It is a good plan to have a rheostat in circuit with the lamp to regulate the intensity of the illumination. On turning on the current and seating ourselves in front of the tank, we shall see a most beautiful corona, caused by the scattering of the light of the lamp by the small particles of mastic suspended in the water. If we look at it through a Nicol prism we shall find that it is radially polarised, a dark area appearing on each side of the lamp, which turns as we turn the Nicol. The illumination is not uniform around the lamp, owing to unsymmetrical distribution of the candle-power, and this heightens the effect. If the polar streamers are found to be too sharply defined or too wide, the defect can be easily remedied by altering the tinfoil strips. The eclipse is not yet perfect, however, the illumination of the sky background being too white and too brilliant in comparison. By adding a solution of some bluish-green aniline dye (I used malachite-green), the sky can be given its weird colour and the corona brought out much more distinctly. If the proper amount of the dye be added, the sky can be strongly coloured without apparently changing the colour of the corona in the slightest degree, a rather surprising circumstance, since both are produced by the same means.

We should have now a most beautiful and perfect reproduction of the wonderful atmosphere around the sun, a corona of pure golden white light, with pearly lustre and exquisite texture, the misty streamers stretching out until lost on the bluish-green background of the sky. The rifts or darker areas due to the unequal illumination are present as well as the polar streamers. The effect is heightened if the eyes are partially closed.

A photograph of one of these artificial eclipses is reproduced in Fig. 3. Much of the fine detail present in the negative is lost in the print, and still more will doubtless go in the process of reproduction. No especial pains were taken to get the polar streamers just right.

R. W. WOOD.
University of Wisconsin.

Sexual Dimorphism.

I CRAVE your leave to reply to one part of the careful and considerate criticism with which Prof. Meldola has honoured my book on "Sexual Dimorphism." He declares his inability to see any force in one of the crucial arguments of my theory, namely, that concerning unisexual inheritance, or, in Darwin's phraseology, heredity as limited by sex. He asks, Why should characters mechanically impressed upon the male during a particular period of his life be hereditary, and characters arising by spontaneous variation at that period not be hereditary? But this is not the question we have to consider. The question discussed in my argument is, Why should characters arising by spontaneous variation at any period of life in one sex be inherited by offspring of the same sex, and not by offspring of the opposite sex?

Prof. Meldola maintains that *on either hypothesis* all characters must originate in an individual which must be either male or female, and asks why there should ever be any blending of characters at all. He appears, therefore, to suppose that all spontaneous variations are inherited only by offspring of the same sex as the parents in which they occurred. It is well known that this is not the case. Many instances are on record in which additional fingers have occurred in a man, and have been inherited by both male and female descendants. I have myself much experience in breeding mice, and in them, although the colours of the parents do not blend perfectly or always in the offspring, yet the colour of the male parent is not more often inherited by male progeny than by female. On the other hand, blending often occurs, and if a male pouter pigeon is matched with a female fantail, the male progeny are not perfect pouters, nor the female perfect fantails.

Darwin has discussed the question in a well-known passage ("Descent of Man," 2nd edit. p. 231): "If a breeder observed that some of his pigeons varied into pale blue, could he, by long continued selection, make a breed in which the males alone should be of this tint, whilst the females remained unchanged? I will here only say that this, though perhaps not impossible, would be extremely difficult; for the natural result of breeding from the pale blue males would be to change the whole stock of both sexes to this tint. If, however, variations of the desired

tint appeared, which were from the first limited in their development to the male sex, there would not be the least difficulty in making a breed with the two sexes of a different colour, as, indeed, has been effected with a Belgian breed, in which the males alone are streaked with black."

The necessary assumption of the theory of sexual selection therefore is, not that spontaneous variations are always inherited unisexually, but that congenital variations occur and have occurred in certain species which from the first were limited in development to one sex. The selection or preservation of such variations does not explain their unisexual or other limitations. It might be suggested or maintained that spontaneous hereditary variations, limited to one sex, to one period of life, or to one season of the year, are liable to occur and have occurred in all species, but have been only selected and preserved in some. But I do not know that this is maintained by selectionists, and at any rate I know of no evidence to support such a contention.

The questions I have considered are, Why have such hereditary variations occurred in some species and not in others? Why are they so closely correlated with the functional activity of the testes, actually failing to develop normally in castrated animals? Why do they always, so far as we know, correspond to the special stimulations involved in the behaviour of the animals under sexual excitement?

Prof. Meldola asks, Why should my view be supposed to account for the limitation of the male characters to the male and the Darwinian view to fail? Surely it is obvious that Darwin's theory merely assumes that variations have occurred which from the first were limited in development as the characters are, while my theory is that they were so limited in development because they were due to stimulations similarly limited.

When Prof. Meldola suggests that the female has had any tendency to inherit the male characters eliminated by natural selection, he seems to me to be repeating an empty formula. There is no ground for supposing that any selection could eliminate such a tendency, and, further, it is an established fact that the tendency has not been eliminated; the female inherits the characters potentially, but in her they usually remain suppressed and latent to appear in actual development under certain conditions. J. T. CUNNINGHAM.

Penzance, December 29, 1900.

MR. CUNNINGHAM'S reply does not appear to me to shed any new light upon the subject of unisexual inheritance, and I can only adhere to the statement expressed in my review. Why he credits me with the supposition "that all spontaneous variations are inherited only by offspring of the same sex as the parents in which they occurred" is beyond my comprehension. There is nothing in my criticism of his views which warrants this, and I need hardly add that the facts which prove such a supposition to be erroneous are quite as familiar to me as they are to Mr. Cunningham. The real point at issue is a comparatively simple one. The author of the book insists that the theory of sexual selection fails to account for unisexual inheritance, and that his theory does account for this phenomenon. Again, it may be asked, why? The answer given above is simply a repetition of his opinion, as already published—the characters are so limited "*because they were due to stimulations similarly limited.*" That is to say, that in every case where the male possesses distinctive secondary sexual characters, these have been produced by direct stimulations acting on the male only, and are, therefore, limited by heredity to the male. Now Mr. Cunningham has just pointed out that transference of male characters to the female does take place, that blending of characters may, and does, occur, and that male characters may, under certain circumstances, appear in the female—a series of facts which we have all been familiar with ever since we became students of Darwin's writings. These facts are absolutely inexplicable on the "direct stimulation" theory. If the stimulations which produced a male character necessitate the restriction of that character to the male, then the only way of escaping from the dilemma in which the author has placed himself is to make one of two additional assumptions:—(1) The characters so blending are not secondary sexual characters, which would be simply resolving the question at issue into a verbal juggle; or (2) that in all cases where there is blending or transference, the same "stimulations" have acted upon both sexes. This last assumption is, however, opposed to the entire spirit of Mr. Cunningham's book, the whole burden of which is that there has been *dissimilarity* of "stimulation" between the sexes.

I should like to add, in concluding, that my own opinion as to the value of Mr. Cunningham's book is in no way shaken through my inability to accept his amended Lamarckism. Out of gratitude for the body of facts which he has collected, I will even go so far as to meet that much-hackneyed reproach of "repeating an empty formula" which anti-selectionists are so fond of using. For, after all, an empty formula, being (by definition) a formula containing no terms, is a negative kind of expression, and if it cannot, by virtue of its vacuity, do much to advance science, it cannot, on the other hand, do any harm. But a formula which contains erroneous terms may throw us off the track altogether, and my contention is that erroneous terms exist in Mr. Cunningham's formula. R. MELDOLA.

Direction of Spirals in Horns.

IN investigating the causes of directions of various spirals, I discovered a certain law and order in the arrangement of the direction of the spiral in horns which will interest many of your readers.

(1) That in the antelopes the right-hand spiral is on the left of the head, and the left-hand spiral on the right of the head (crossed). (2) That in sheep the right-hand spiral is on the right of the head, and the left spiral on the left side of the head (homonymous, or same name). The *wild* goats agree with the antelopes in regard to the spiral direction of their horns (crossed), and the oxen agree with the sheep in cases where the spiral can be noted (homonymous). Exceptions are not numerous and not difficult to remember, but this letter is not intended to do more than record the usual rules for spiral directions in horns.

If these observations be of value in clearness of description of a difficult point, it will be a gain; and they may also prove useful in classification. By taking a corkscrew (or a right-handed spiral) in the hand, it is easy to verify on the horns themselves the direction of their spiral curves. GEORGE WHERRY.

Cambridge.

Liquid Air.

THE notion that Virgil had an idea of "liquid air" because he speaks of "liquidus aer," is like the idea that Euripides was a smoker because a line of his may have begun

τὸ βακχικὸν δώρημα δός.

But there is a very curious anticipation of Prof. Dewar's discovery in Lucian's "Vera Historia" Book ii 89. Lucian there tells us that the inhabitants of the moon drink ἀὴρ ἀποθλιβόμενος ἐς κύλικα, "air squeezed or compressed into a goblet." I do not know whether liquid air has yet been used as a beverage, but in other respects the passage seems to be an exact description of the substance in question. J. ADAM.

Emmanuel College, Cambridge, December 30, 1900.

A Nest of Young Starlings in Winter.

WHILE a friend was walking through his fields near Broxbourne on Sunday afternoon, the 6th inst., he noticed a starling flying towards an an old elm with some food in its bill, and on going up to the tree he found a nest containing young birds. No doubt they are dead by this time, on account of the severe cold and the difficulty the old birds found in obtaining food for them. R. H. F.

January 8.

SOME ANIMALS EXTERMINATED DURING THE NINETEENTH CENTURY.

WHILE the century which has just closed may fairly lay claim to the gratitude of posterity on account of the magnificent tale of zoological work accomplished during its course, it is, on the other hand, undoubtedly open to the charge of having permitted the total extermination of not a few animals, and of having allowed the numbers of others to be so reduced that their disappearance, at least as truly wild creatures, can scarcely be delayed very many years longer. Possibly, if not prob-

ably, the sweeping away of the enormous herds of many species, like those of the American bison, may have been an inevitable accompaniment of the march of civilisation and progress; but there is no sort of excuse to be made for the fact that in certain instances naturalists failed to realise that species were on the very verge of extermination, and that they were actually allowed to disappear from the world without being adequately represented in our museums. Nor is it by any means certain that even the present generation is altogether free from reproach in this matter, although it cannot be said that any species hovering on the verge of extermination are absolutely unrepresented in collections. Whether, however, sufficient specimens of such species are being preserved for our successors may be an open question.

It is not our intention in this article to allude to the host of animals whose numbers have been reduced in such a wholesale manner during the century as to render them in more or less immediate danger of impending extermination, but to confine our attention in the main to those on whom this fate has already fallen. And here it may be mentioned with satisfaction that India enjoys a remarkably good record in this respect, for, so far as we are aware, it has not lost a single species of mammal, bird or reptile, either during the nineteenth century or within the period of definite history. It is true that the numbers and range of the Indian lion have been sadly curtailed during the last fifty years, and that if steps are not promptly taken for its protection that animal may, ere long, disappear from the Indian fauna. But, at any rate, it has not done so at present; and even were it exterminated in the country, this would not mean the extermination of a species, and possibly not even of a local race, since it is not improbable that the Persian representative of the lion (which is still abundant) may not be distinguishable from the Indian animal. Of large animals peculiar to India, perhaps the great Indian rhinoceros is the one that requires most careful watching in order that its numbers and its range may not be unduly reduced before it is too late to take adequate measures for its protection. And in this connection it is perhaps legitimate to call the attention of sportsmen and native princes to the urgent need of a fine specimen of this magnificent animal for the collection of the British Museum.

We have said that the century is responsible for the extinction of no inconsiderable number of the world's animals. But it must not for one moment be supposed that, within the historic period, no such exterminations by human agency had taken place in previous centuries. We have to go back so far as the year 1615 for the last evidence of the existence, in a living state, of the great flightless rail (*Aphanapteryx*) of Mauritius and Rodriguez; while the journal of the mate of the *Berkley Castle*, in 1681, is the last record of the dodo being seen alive. Again, the tall and flightless solitaire of Rodriguez is not definitely known to have been met with by Europeans after 1691, although there is some evidence to indicate that it may have lingered on in the more unfrequented portions of the island till as late as 1761. Of the extinct géant, or Mauritian coot (*Leguatia*), we have no evidence of its existence subsequent to 1695; while our last record of the crested parrot (*Lophopsittacus*) is as far back as 1601. Again, the great northern sea-cow (*Rhytina gigas*), which was only discovered on the islands of Bering Sea in the year 1741, had entirely ceased to exist by about 1767. Moreover, the giant tortoise of Réunion appears to have ceased to exist on its native island previous to the dawn of the nineteenth century, although at least one exported example has survived till our own day.

Neither can the nineteenth century be held responsible for the extermination of the South African blaauwbok (*Hippotragus leucophoeus*), a smaller relative of the familiar roan antelope, since the last known example is believed to have been killed in or about the year 1799. It had always a curiously restricted habitat, being confined to a small area in the Swellendam district.

On the other hand, the great auk is a bird whose loss we owe to the carelessness of the naturalists of the middle of the nineteenth century, for there is little doubt that if protective measures had been taken in time it might have been alive at the present day. From the American side of the Atlantic it probably disappeared somewhere about the year 1840; while the summer of 1844 witnessed the destruction of the last European pair of this remarkable bird, the last British representative having been hunted to death in the neighbourhood of Waterford Harbour ten years previously.

One of the most sad stories of extermination, and that, too, at a comparatively recent date, is revealed in the case of the South African quagga. According to Mr. H. A. Bryden, who has devoted a great deal of attention to the subject, the extermination of this zebra-like species in the Cape Colony took place between the years 1865 and 1870, and probably between the latter year and 1873 in the Orange River Colony, which was its last stronghold. The extermination of this species may be attributed entirely to the pernicious trade of hide-hunting, for in the first half of the century it was to be met with in thousands on the grass *veldt*, and formed the staple food of the Hottentot farm labourers of the Graaf Reinet and many other districts. What makes the matter still more melancholy is that specimens of the animal could easily have been procured in any numbers, both for our menageries and our museums, but that (probably owing to the circumstance that naturalists were ignorant of its impending fate) no steps were taken in the matter. In the year 1851 a female was purchased by the Zoological Society of London, while seven years later a male was presented to the same body by the late Sir George Grey. The latter survived till 1872, and was thus one of the last survivors of its race. Although the fact of the practical accomplishment of the extermination of the species at that time appears to have been unknown in London, the skin of Sir George Grey's specimen was luckily preserved, and may now be seen mounted (albeit in a somewhat worn and faded condition) in the British Museum as the solitary representative of the species. Fortunately the skeleton of this specimen was likewise preserved for the national collection.

Several photographs of the above-mentioned individual are in existence, and the Royal College of Surgeons possesses a small oil-painting, by Agassiz, of one of a pair of quaggas which were driven in harness by Mr. Sheriff Parkins in Hyde Park early in the nineteenth century. Of these two animals the College likewise possesses the skulls, which were acquired with the collection of Mr. Joshua Brookes on its purchase in 1828.

In addition to Sir George Grey's specimen, the British Museum formerly had the skin of a young quagga, in very bad condition, which was presented by the traveller William Burchell, and was subsequently described by Hamilton Smith as a distinct species, under the name of *Hippotigris isabellinus*. Apparently London museums possess no other relics of this lost species, of which, however, we believe there is an example in the museum at Edinburgh. As the animal yielded no trophies worthy the attention of the sportsman, it is unlikely that there are any specimens in private collections, unless, perchance, a skull or two may be in existence. The lack of other relics of such a common species affords a signal instance of lost opportunities, and should serve as a warning against our permitting a similar remissness to occur in the case of any other species threatened with extermination.

Mention has already been made of the extermination of the giant land tortoise of Réunion during the

eighteenth century; and in the early part of its successor four other species became extinct in the neighbouring islands of the Mascarene group, namely, *Testudo indica*, *T. triserrata* and *T. inepta* in Mauritius, and *T. vosmaeri* in Rodriguez. It has likewise been considered probable that the thin-shelled tortoise (*T. abingdoni*), of Abingdon Island, in the Galapagos group, is also no longer existing, although it was certainly alive as recently as 1875.

Of birds that have disappeared during the century, in addition to the great auk, reference may first be made to the black emeu (*Dromaeus ater*), of Kangaroo Island, South Australia. When this island was explored in 1803 by a French expedition these birds were abundant, and three were sent home to Paris, where a pair lived till 1822. On their death, the skin of one and the skeleton of the other were mounted for exhibition in the Paris Museum, where they still remain. Of the third specimen no record was obtainable till 1900, when, as already noticed in this journal, its skeleton was discovered by Prof. Giglioli in the museum at Florence. These three priceless specimens are the only examples of a species which became extinct in the native state previous to the death of the Paris pair, and before it was even known to be different from the larger emeu of the mainland. For it appears that some years after the visit of the French expedition (to which Péron was naturalist) to Kangaroo Island, a settler squatted there and forthwith set to work to make a clean sweep of the emeus and kangaroos—a task in which he was only too successful.

Before the middle of the century another large bird appears to have made its final exit from this world. When Steller discovered the northern sea-cow in the islands of Bering Sea, he also brought to the notice of science a new species of cormorant (*Phalacrocorax perspicillatus*), which was especially interesting on account of being the largest representative of its kind, and likewise by the bare white rings round its eyes and the brilliant lustre of its green and purple plumage. Stupid and sluggish in disposition, Pallas's cormorant, as the species is commonly called, appears to have been last seen alive about the year 1839, when Captain Belcher, of H.M.S. *Sulphur*, was presented with a specimen by the Governor of Sitka, who also forwarded other examples to Petersburg. Captain Belcher's specimen is preserved in the British Museum, and three other skins are known to be in existence elsewhere.

The great white water-hen (*Notornis albus*), formerly inhabiting Lord Howe and Norfolk Islands, must be added to the defunct list. And the same is the case with the Tahiti rail (*Prosobonia leucoptera*) and Latham's white-winged sandpiper (*Hypotaenidia pacifica*), the latter of which in Captain Cook's time was abundant in the island above named, as well as in the neighbouring Eimeo. The New Zealand quail (*Coturnix novaezealandiae*) is likewise entered in the British Museum list as extinct. The beautiful "*Pigeon hollondais*," so-called from its plumage presenting the Dutch colours, and technically known as *Alectoroenas nitidissima*, is a Mauritian species whose extermination probably took place during the century. It is known solely by three examples, one of which is preserved at Port Louis, the second in Paris, and the third in Edinburgh.

Nor must we omit from our list two species of Kaka parrot, one of which (*Nestor productus*) was a native of Philip Island, while the home of the second (*N. norfolcensis*) was the neighbouring Norfolk Island. A species of parraquet (*Palaeornis exsul*), peculiar to the island of Rodriguez, is also believed to be exterminated.

Neither has the duck family escaped, for the well-known pied duck (*Camptolaemus labradorius*), an ally of the eider from the North Atlantic coast of America, appears in the defaulters' list, the last-known example having been killed in 1852.

Passing on to Passerine birds, a notable loss is the handsome crested pied starling, *Fregilupus varius*, which is believed to have become extinct about the middle of the century. Of the few remaining examples of this striking species one is preserved in the British Museum. Another species, exterminated within approximately the same period, is the gorgeous black and gold mamo, or sicklebill (*Drepanis pacifica*), of Hawaii, whence it was first brought to Europe by Captain Cook. As narrated in the "Birds of the Sandwich Islands," by Messrs. Scott Wilson and Evans, the extermination of this beautiful species is to be attributed to persecution for the sake of its yellow feathers, which were used for the cloaks of the native chiefs. About four specimens are known to be preserved in museums.

Of birds that have been locally exterminated, such as the burrowing petrel (*Œstrelata haesitata*), known in the Antilles as the diablotin, it is not our intention to speak on this occasion. And this article may accordingly be fitly brought to a close by an extract from Prof. A. Newton's "Dictionary of Birds," referring to two instances where species may have perished within the century without having ever come definitely under the notice of ornithologists. After stating that one Ledru accompanied an expedition dispatched by the French Government in 1796 to the West Indies, the Professor proceeds to observe that this explorer "gives a list of the birds he found in the islands of St. Thomas and St. Croix. He enumerates fourteen kinds of birds as having occurred to him then. Of these there is now no trace of eight of the number; and, if he is to be believed, it must be supposed that within fifty or sixty years of his having been assured of their existence they have become extinct. . . . If this be not enough we may cite the case of the French islands of Guadeloupe and Martinique, in which, according to M. Guyon, there were once found six species of Psittaci, all now exterminated; and it may possibly be that the macaws, stated by Gosse and Mr. March to have formerly frequented certain parts of Jamaica, but not apparently noticed there for many years, have fallen victims to colonisation and its consequences." R. L.

CLIMBING IN THE HIMALAYAS.[1]

DURING an extended cycling tour in the East, the authors spent the summer months of 1898 and the following year in the Himalayas. In the former season they penetrated from Srinagar, which they had reached on their vehicles, into the mountains of Ladakh, Nubra, and Suru, and, later on, into Sikkim from Darjeeling. Next year they took with them Matthias Zurbriggen, who had been guide to Sir Martin Conway on his memorable journey in 1892, retracing his steps up the Biafo Glacier to the Hispar Pass, and then making some important ascents in the district about the Skoro La Pass. Altogether they were encamped for many days at altitudes not less than 16,000 feet, crossed several passes more than a thousand feet higher, and made the ascent of three virgin icy summits, rising to heights of 18,600, 19,450, and 21,000 feet respectively. Thus Mrs. Workman not only is the first of her sex to do serious mountain work in the Himalayas, but also has been higher than any of them above sea-level.

Climbing in the Himalayas, as the authors remark, is a much more serious affair than in the Alps. The glaciers and peaks, as shown by the excellent illustrations, one of which is appended by the courtesy of the publisher, are certainly not less difficult; roads are often wanting, mountain inns and chalets always; the camp

[1] "In the Ice World of Himalaya, among the Peaks and Passes of Ladakh, Nubra, Suru, and Baltistan." By Fanny Bullock Workman and William Hunter Workman, M.A., M.D. With three maps and sixty-seven illustrations. Pp. xvi + 204. (London: T. Fisher Unwin, 1900.)

must be pitched far away from even the smallest of towns; provisions, wraps, tents, all requisites, must be transported by human labour, which is costly and entails endless difficulties. The misdeeds of porters were once a stock subject of complaint among alpine climbers, but the worst of them are surpassed by Indian coolies, who are ill-fed, ill-clad and without mountain experience, while the native servants, almost universally, are adepts in cheating and mendacity. Through their misconduct one expedition, that into Sikkim, was a complete failure; and on this occasion the travellers apparently had good reason to complain of the British Political Officer at Darjeeling—not the one, it may be observed, whose courtesy Mr. D. Freshfield experienced on his tour round Kinchinjanga.

On the second year's journey they plunged more deeply into the Himalayan ice world. After reaching Askole by the Skoro La Pass, nearly 17,000 feet above sea-level, they ascended the Biafo glacier, which had shrunk and changed since 1892, to the Hispar Pass, from which they obtained splendid views of the neighbouring snowy giants, afterwards returning to Askole. Again leaving it they pitched a camp above the Skoro La Glacier, 16,200 feet from sea-level, at which, or a higher one, they remained for six days. From it they ascended the Siegfriedhorn, an excellent point of view 18,600 feet high, and the snowy Mount Bullock Workman, 19,450 feet. Returning over the Skoro La Pass they struck up the Shigar Valley, and finally, from a camp 17,900 feet above sea-level, reached, in unfavourable weather, the summit of Koser Gunge, about 21,000 feet.

The book is pleasantly written, though we cannot think such words as "itemized" and "motived" valuable additions to the English language. In addition to vivid descriptions of the scenery, it records, though professedly a work on mountain travel, some facts of scientific interest. The authors, like all recent travellers in the higher Himalayas, were struck with the signs of rapid disintegration. The great changes of temperature shatter the rocks, and strew the mountain flanks with fragments, forming huge slopes of débris and great alluvial fans. On one occasion they had a rather narrow escape when "a mixture of solid and semi-solid bodies," consisting of "mud and stones of every size, some of them many tons in weight, which were rolled on one another as if they were pebbles, poured down a glen, sweeping everything before it"—a mass twenty to thirty feet in height and some sixty yards in breadth. The work of mountain sculpture evidently proceeds more rapidly in the Himalayas than in the Alps. Yet there was probably a time when the latter passed through a similar stage. Mud glaciers, if the phrase be permitted, are not unknown in them, but much material, often hastily classed as moraine, is really of very composite origin, and is transported more by water than by ice.

The last chapter of the book, which gives a summary of their experiences of the effects of diminished atmospheric pressure, has a special value because Dr. Workman can speak as a medical expert. They lived for many days at heights between fourteen and seventeen thousand feet, sleeping several times in camps between sixteen and eighteen thousand feet, and thrice reached elevations between the last and twenty-one thousand feet. Their experiences agree generally with those of Whymper, Conway, FitzGerald and Vines. Below 15,000 feet Dr. Workman noticed no great departure from the normal. In the higher camps he slept well, though Mrs. Workman did not; they had good appetites, neither suffered from mountain sickness or, with one exception in each case, from headache, and this they attributed to cold rather than diminished atmospheric pressure; but both, like all their predecessors, felt the effects of the latter increasingly perceptible after rising above some 16,000 feet. They made slower progress, got more readily out of breath, and from about 18,000 feet upwards found that all movements, even stooping or altering the position when at rest, had to be made with deliberation—even holding the breath for a moment to take a snap-shot with the camera was followed by gasping. But by accommodating themselves to the conditions they climbed without severe discomfort, and did not find that

FIG. 1.—Siniolehum, Sikkim.

this materially increased in the ascent to the highest point attained. The commissariat, in Dr. Workman's opinion, is a most important factor for success in reaching great elevations, since he holds dyspepsia and imperfect nutrition responsible for the distressing symptoms experienced by some of his predecessors. Food should be rather light, but nutritious. He makes some valuable remarks on the best kinds, stating that he thinks alcohol beneficial if it be taken in very moderate quantities and at meal times; warm wraps also are most important. In fact, his careful discussion of the subject is a valuable supplement to what has been already published, and proves that climbers anxious to reach the highest summits of Asia must possess either the *dura messorum ilia* or the purse which can bear the very heavy cost of a well-equipped expedition. T. G. BONNEY.

THE ROYAL INDIAN ENGINEERING COLLEGE.

FROM letters which have been published recently in the *Times* and other journals, we have become aware of the following facts relating to the Royal Indian Engineering College, Coopers Hill:—

(1) The Secretary of State for India, acting on certain suggestions, made to him ostensibly by the Board of Visitors of the College, for remodelling the course of instruction on a very extensive scale, decided, some considerable time back, that it was necessary to dismiss *half the educational staff* of the College for the purpose of "reducing the present excessive cost of the staff and increasing the efficiency of the teaching."

(2) No hint that this momentous change was coming was conveyed to any of the seven gentlemen concerned, who received their first intimation on the 17th of last month from the President of the College, Colonel J. W. Ottley, in a letter of singular abruptness, heartlessness and irony. This letter, addressed to each of the seven gentlemen, was as follows:

"Sir, I have the honour to forward for your information a copy of a letter, P.W. 2531, dated 14th inst., from which you will see that I am instructed to convey to you the decision of the Secretary of State for India in Council that you will be required to vacate your appointment at this College at the end of the next Easter term.

"I have the honour to be, Sir, your obedient servant,
"JOHN W. OTTLEY, President, R.I.E.C."

The seven gentlemen to whom this communication was made are Mr. T. A. Hearson, M.Inst.C.E., Professor of Hydraulic Engineering, &c.; Mr. H. McLeod, F.R.S., Professor of Chemistry; Mr. W. N. Stocker, M.A., Professor of Physics; Mr. A. H. Heath, Assoc.M.Inst.C.E., Assistant Professor of Engineering; Mr. T. Shields, M.A., Demonstrator in Physics; Mr. P. Reilly, Demonstrator, Mechanical Laboratory; Mr. J. C. Hurst, Lecturer in Accounts.

With reference to the first of these facts we may affirm with confidence that the drastic changes—which involve serious curtailments of the branches of engineering and chemistry, and, apparently, the total abolition of physics and electrical engineering—are not to be attributed to the Board of Visitors. It is not credible that these gentlemen—very busy men as some of them are—can have devoted so much time and study to the educational course of the College as to justify their taking the responsibility of advising the Secretary of State for India to effect such extensive changes. We are compelled to adopt the conclusion that Colonel Ottley (whose name appears for the first time in the College Calendar for 1899-1900) himself is the real author. If this is so, we are further compelled to inquire into Colonel Ottley's qualifications as an educationist and a man of science. We are not acquainted with any scientific treatises or papers of his authorship, nor are we aware that he was selected as the head of a scientific college because of any experience as a lecturer on scientific subjects. His predecessors at the College have been, we believe, like himself, officers of Royal Engineers; but, apparently, they were wise enough to keep their theoretical autocracy as presidents within the limits prescribed by common sense.

From the memorial addressed by the dismissed members of the staff to the Secretary of State we infer that Colonel Ottley interprets his autocracy very literally, and is disposed to take no advice from the educational staff on matters of which they must necessarily know vastly more than he; and if so, it ought to be abundantly clear to the India Office that Coopers Hill College must be, as an educational institution, a complete failure.

It will be observed that the subjects which are most affected by the change—chemistry, physics and the mechanical laboratory—are those in which practical work has an important place; it is well known to those experienced in scientific education that this practical work is of the greatest value in developing in students the scientific spirit which is so essential to success in such a profession as engineering. We believe that the laboratories at Coopers Hill were enlarged some years ago and the staff increased, so that every student should have instruction in the chemical, physical and mechanical laboratories, on the recommendation of the Board of Visitors; but at that time one of the members of the Board was Sir William Siemens, who, knowing the result of practical work in the German universities upon industries and professions, considered its further development at Coopers Hill to be of importance. The present action appears to be in direct opposition to the former recommendations of the Board of Visitors.

Turning our attention next to the second of the above facts, we are compelled to express not only astonishment but indignation that such heartless brutality should have been possible in England. To know that seven gentlemen—two of them members of the Institution of Civil Engineers and another a Fellow of the Royal Society—are to receive a three months' notice of dismissal, timed, as it would seem, by the clock; to know that it must be of the utmost importance to them to be warned of the impending catastrophe so that they may have opportunities for seeking other work; and yet to keep their sentence a dead secret until the last available moment, constitutes a condition of mind which, we hope, is very rare among Englishmen.

The cause of Coopers Hill College is, in this matter, the cause of education at large. All that the dismissed members of the staff have asked from the India Office is that an independent committee of experts in scientific engineering, education, and college management should be appointed to inquire into the way in which the College is managed.

But we go beyond this request. We would make an appeal to men of science and of learning to make, either by deputation or by memorial, a representation to the India Office of the widespread feeling of disapproval with which this official action, for which the Secretary of State for India is responsible, is regarded, and of the desirability of ensuring to the educational staff of the College at Coopers Hill such influence in educational matters as is accorded in every College in the Kingdom.

NOTES.

PROF. STRASBURGER has been elected a correspondant of the Paris Academy of Sciences, in the section of botany.

THE death is announced of Dr. Potain, professor of medicine in the University of Paris, and member of the section of medicine and surgery of the Paris Academy of Sciences.

IT is announced by *Science* that Prof. W. W. Campbell has been appointed director of the Lick Observatory, in succession to the late Prof. J. E. Keeler.

AT a special meeting of the Metropolitan District Railway Company on Monday, it was resolved that capital should be raised for the purpose of adapting the line to electric traction. This action has been forced upon the company by the diversion of traffic to the Central Electric Railway, and omnibus competition.

WE regret to announce the death of Dr. G. Pacher, of Padua University, on December 29, at the age of thirty-three. We owe to him some valuable studies of the records of the Vicentini microseismograph, and also the application of the pantagraph to that instrument.

THE Board of Trade have appointed a committee consisting of Lord Rayleigh, F.R.S., chairman, Sir John Wolfe-Barry, K.C.B., F.R.S., and Prof. Ewing, F.R.S., to consider to what

extent the working of the traffic on the Central London Railway produces vibration in the adjacent buildings, and what alterations in the conditions of such working or in structure can be devised to remedy the same.

THE dispute between Kew Observatory and the London United Tramways Company still occupies public attention. Mr. R. T. Glazebrook, in a letter to the *Times*, gives an answer to the argument brought forward by the Tramways Company that the current leaking into their lines, presumably from the Central London Railway, should have already vitiated the magnetic observations made at Kew. He points out that the observations have not been appreciably affected, and that from theoretical considerations it was not to be expected that they would be. The disturbances that the London United Tramways Company are likely to produce will be about a hundred times as serious. Mr. Glazebrook has given a proof of this in a letter to the *Electrician*. A letter to the *Times* from Mr. Walter Hunter points out that the leakage currents from the tramway lines are a serious danger to gas and water pipes, and that the amount of harm done is merely a question of time. Perhaps it is too much to expect the Tramways Company to consider any but their own interests; it is to be hoped, however, that they will be brought to see that it is really to their own interest to insulate their return mains. There is no difficulty in doing so, and sooner or later it will have to be done. We notice that American experience shows that the only way to avoid electrolysis of the pipes is to keep the return currents out of the ground, and also that an experience from ten years running of over 200 miles of track shows that the double trolley system—which the London United Tramways Company consider impracticable—is cheaper in operation and maintenance than the single trolley system.

THE annual general meeting of the Royal Meteorological Society will be held on Wednesday, January 16, when the president, Dr. C. Theodore Williams, will deliver an address on "The Climate of Norway and its Factors."

THE *British Medical Journal* states that the Astley Cooper triennial prize of 300*l.* will be awarded for the best essay or treatise on "The Pathology of Carcinoma and the Distribution and Frequency of the Secondary Deposits corresponding to the Various Primary Growths." The essay, which is to be written in English, must reach Guy's Hospital, addressed to the physicians and surgeons, on or before January, 1904.

COL. A. T. FRASER sends us a copy of the *Indépendance Belge* to direct our attention to a matter brought before the last meeting of the Brussels Academy of Sciences. From the report we see that M. Charles Lagrange, director of the Royal Observatory, has resigned his office and has presented to the Academy his two years' arrears of salary, or a capital sum of ten thousand francs, to establish a prize to be awarded, at intervals of four years, for the best contribution to our knowledge of the physics of the globe. In expressing the thanks of the Academy for the gift, General Brialmont described the circumstances which led to M. Lagrange's resignation. It appears that for the past two years the position of director of the Observatory has been a humiliating one, because a young infantry officer without scientific attainments has controlled the establishment.

WE regret to announce the death of Mr. F. W. Egan, B.A., of the Geological Survey of Ireland, which took place at his residence in Dublin on January 6. After some experience as a civil engineer, he joined the Geological Survey under Jukes in 1868, and has ever since that date been actively engaged in the field-work of the service. For the last few years he devoted himself to the revision of the Silurian system in the east of Ireland, and separated the Lower from the Upper division over a large part of that region. Eighteen months ago, during a tour of inspection in County Wicklow, the Director-General of the Survey, with Messrs. Egan and McHenry, were thrown from an Irish car. Though each of the party sustained more or less injury, Mr. Egan fared worst. He had his shoulder dislocated, and suffered also some internal injury, so that he never regained his former strength, though he went through the field-campaign last year. Last week, symptoms of a grave kind began to show themselves, and he passed away on Sunday evening. Quiet, gentle and kindly, and not without a touch of humour, he was everywhere a favourite, and though he never had any ambition to distinguish himself, his long years of steady and patient devotion to his official duties enabled him to do good service to the cause of geology in Ireland.

THE Berlin correspondent of the *Times* announces that the German Emperor has conferred the Order of the Red Eagle, First Class, upon Lieutenant-General Count von Zeppelin, as a recognition of his efforts to overcome the difficulties of aërial navigation. The announcement of this distinction was made to Count von Zeppelin by the following letter from the Emperor, which was conveyed to him by General von Hahnke, the chief of the Emperor's Military Cabinet, before the beginning of a lecture upon the "Future of Aërial Navigation," delivered by the aëronaut at a meeting of the Berlin branch of the German Colonial Society:—"Having been informed of the ascents which have been made in the air-ship which you have invented, I am glad to express my appreciation of your persistence and trouble in successfully carrying out your self-imposed task, in spite of the manifold difficulties which it presented. The advantages of your system—the division of the long, extended balloon into compartments, the equal distribution of the burden by means of two independent engines, and a rudder working with success for the first time in a vertical direction—have enabled your air-ship to move with the greatest speed which has hitherto been attained and have rendered it amenable to the rudder. The results which you have achieved constitute an epoch-making step in advance in the construction of air-ships, and form a valuable basis for further experiments with the existing material. I will support you in these further experiments by placing the advice and the experience of the Balloon Division of the army at your disposal whenever you may desire. I have accordingly given orders to the Balloon Division to send an officer to be present at your future experiments whenever it may be of advantage. As an outward sign of my recognition I hereby confer upon you the Order of the Red Eagle, First Class."

THE annual general meeting of the Institution of Mechanical Engineers will be held on Friday evening, January 18, when the chair will be taken by the president, Sir William H. White, K.C.B., F.R.S. The first presentation by the Institution of the Willans Premium will be made to Capt. H. Riall Sankey; and the prizes awarded by the Council for the best two papers in the graduates section will be presented to Mr. W. B. Cleverly and Mr. Brees van Homan. The adjourned discussion will be resumed upon the paper on power-gas and large gas-engines for central stations by Mr. Herbert A. Humphrey, read at the December meeting. At the graduates' meeting, to be held on Monday, January 14, Prof. J. A. Ewing, F.R.S. will deliver a lecture at the Institution on "The Structure of Metals," illustrated by lantern slides.

ENTOMOLOGY has sustained a serious loss in the death of Mr. John Henry Leech, which occurred on December 29, at the early age of thirty-eight. Mr. Leech, who had one residence at Hurdcott House, Salisbury, and a second at Kippure Manor, Kilbride, Dublin, was the eldest son of the late Mr. John Leech, of Gorse Hall, Cheshire, and was a graduate of Cambridge. In addition to being proprietor of the *Entomologist*, he was author of "The Butterflies of China, Japan and

Corea," a work for which he accumulated a large collection (part of which is now in the Natural History Museum) during his travels in the countries mentioned. If, as seems probable, his premature death was due to hardships and exposure during those travels, his name may be added to the list of martyrs in the cause of science. Mr. Leech was elected a fellow of the Zoological Society in 1885, and was likewise a fellow of the Linnean and the Royal Geographical Societies.

THE fall of two of the stones of the outer circle of Stonehenge, on the last evening of the nineteenth century, directs attention to the necessity for at once taking steps to preserve this remarkable prehistoric monument. The stones ought to be replaced while their original positions are clearly remembered, and before public interest in their fall has subsided. An engineer, writing to the *Times*, suggests a method of undermining the stones and imbedding them in a foundation of concrete or cement. A scheme of this kind would cost comparatively little, and there should be no difficulty in obtaining funds to carry it out. At any rate, the preservation of Stonehenge ought to be given serious consideration without delay, and archæologists should see that something is done to prevent the gradual collapse of this wonderful memorial of the past.

As already announced, a committee of the U.S. House of Representatives has decided to report in favour of the adoption of the metric system of weights and measures. Referring to this, the *Scientific American* makes the suggestion that England should join with the United States in introducing the system at the same time. Our contemporary remarks:—"The probability of the Bill's becoming a law would be greatly increased if the other great branch of the English-speaking race could be induced to make the change simultaneously with this country. The agitation in favour of the metric system is as strong, possibly stronger, in Great Britain as it is here, and in view of the close trade relations and the enormous volume of business between the two countries, it is well worth considering whether an attempt at concerted, or rather simultaneous, adoption of the metric system would not be advisable."

THE Brussels correspondent of the *Times* states that arrangements are in progress for a series of experiments in wireless telegraphy between Brussels and Antwerp, on the Guarini system. The apparatus for transmitting messages is nearly complete in both cities, and has been erected in Brussels in the Place du Congrès and at Antwerp on the tower of the well-known cathedral of Notre Dame. M. Guarini is doubtful whether local conditions will admit of direct communication, and he proposes to utilise Malines Cathedral, situated midway between the two cities, as an automatic repeating station. On the other hand, if it is found practicable, Antwerp itself will be made to serve as a repeating station for other points of the compass. The first trial is to take place on January 20.

DURING the past week the type of weather over the British Islands has entirely changed, the warm south-westerly current having given way to cold north-easterly winds, with high barometric pressure. During the latter part of last week the change of conditions caused a large amount of fog, especially over the southern parts of England, but this was quickly dispelled by a piercing N.E. gale which set in on Saturday evening, and was in turn followed by considerable falls of snow. The temperature was lowest over the midland and southern parts of the kingdom, where readings exceeding 10° below the freezing point have been recorded. This spell of wintry weather has spread over this country from the Continent, where conditions during the week have been abnormal. In Germany the thermometer has fallen below zero, and in France readings of 20° below the freezing point have been registered. Snow has fallen in many parts, and also in Rome for the first time during the last seven years. A rise of temperature occurred over the southern portion of England on Wednesday.

IN the U.S. *Monthly Weather Review* for September last, Mr. H. M. Watts discusses what he calls the Gulf Stream myth. He points out that the mild climate of north-western Europe is not due to the Gulf Stream, but to the prevailing eastward and north-eastward drift of the atmosphere which distributes over Europe the heat conserved by the whole Atlantic Ocean north of latitude 35° (roughly). The Gulf Stream is not distinguishable in temperature or "set," the author states, from the rest of the ocean, by the time it gets east of Newfoundland; and if it were by any possibility to be diverted at the Straits of Florida, no one in England would be a whit the wiser. If the drift of the aërial currents were reversed, the Atlantic Coast States, from North Carolina to Newfoundland, would have the mildness of Bermuda, not on account of any one ocean current, but because of the conserved warmth of the ocean as a whole. As it is, the August hot waves, the mild spells in January and February, and other anomalies which seem at times to reverse the seasons on the eastern coasts of the United States, are due, not to any shifting of the Gulf Stream, but to the intrusion of the anticyclone (or system of high barometric pressure) from the Atlantic Ocean.

WE have received the report of the Economical Society of Livonia, containing the results of the rainfall and air-temperature observations made at some 150 stations in the Russian Baltic provinces during the year 1899. The stations are maintained partly by the Central Physical Observatory of St. Petersburg and partly by the Ministry of Marine, and, to a considerable extent, the monthly and yearly results are included in the publications of the Central Observatory. The Society does good work in establishing a close network of stations, and in publishing the results in more detail than is generally done in the official year-books. The observations have been utilised during the time of harvest by the issue of special forecasts to agriculturists, and such a system is of great utility in endeavouring to discover the various anomalies that are found to exist in the distribution of rainfall, which cannot always be explained by the geographical conditions of the stations.

AN interesting contribution to our knowledge of the laws of vortex motion is given by Herr K. Żorawski in the *Bulletin* of the Cracow Academy, viii., 1900. The deduction of these laws from the equations of hydrodynamics, subject to certain physical assumptions, is mainly due to Helmholtz; the present paper deals with the converse problem of finding the mathematical conditions which must be satisfied by the velocity components in order that the so-called "circulation theorems" may hold good.

UNDER the title of "The transfigurations of a Science," Prof. Gino Loria has published a reprint of his academical address to the University of Genoa, dealing with the history of mathematics. It traces the gradual progress of mathematics from the ancient Greeks to the present day; the introduction of algebra into Europe, the fusion of the two branches of mathematics, algebra and geometry by the creation of analytical geometry; and, lastly, the rising up of the science of non-Euclidian geometry.

UNDER the name of "The Astronomical Demonstrator," Mr. W. H. Adams, of Wandsworth, has recently arranged a series of lecture-models intended to provide a teacher with the means of quickly illustrating, in a practical manner, most of the dispositions and phenomena of the solar system. A large sheet of cardboard or other material is provided with diagrams of the orbits of the planets, &c., and small models of the sun, earth,

moon and planets, with weighted bases and movable axes, are placed in their proper positions on their various orbits as determined from an ephemeris. In addition, there are various appendages capable of attachment to the objects for the illustration of special phenomena, such as eclipses of the sun and moon. The apparatus should be specially useful in classes where it is possible to allow the pupils to individually work exercises in the proper grouping of the planets, as in that way many of the definitions connected with orbital motion are presented in a very simple manner.

A VALUABLE contribution to the climatology of Africa appears in the *Mitteilungen aus den deutschen Schutzgebieten* in the form of records obtained from self-registering meteorological instruments in German East Africa. The period covered extends from the end of 1895 to the end of 1899, and the records, more or less complete in each case, are from the seven stations Dar-es-Salam, Tanga, Kwai, Tosamaganga, Tabora, Kibosho and Muansa.

THE *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains an important article on the question of glaciation in the Central Balkans by Prof. W. Götz. The author's investigations support the conclusions that (1) after diluvial deposits had been laid down in the mountain valleys, the erosive action of the streams greatly increased, probably on account of sinking of the lower courses; (2) the apparent indications of glacial action met with are false; and (3) traces of glacial phenomena are absent where they ought to be most marked, at the higher elevations in regions suited to the formation of snow-fields.

THE Oregon mountaineering club, which has adopted the title *Mazama*, the Indian name of the mountain goat, has just issued the first number of the second volume, or, rather series, of its journal. The number is devoted to Mount Rainier, and includes an account of the expedition of the club to that mountain in 1897. Observations of the mercurial barometer, made at the summit by Prof. Edgar McClure, who lost his life by a fall during the descent, have been reduced by Prof. E. H. M'Allister, and give the height of Mount Rainier at 14,528 feet, compared with 14,519 feet obtained by the United States Geological Survey.

IN an article on the Phyllades of the Ardennes compared with the Slates of North Wales (Part ii. *Proc.* Liverpool Geol. Soc., 1900), Mr. T. Mellard Reade and Mr. P. Holland state their conclusions that slaty cleavage is not alone a mechanical effect, but that it is mainly due to a development of flaky minerals in conjunction with the shearing forces to which the slate rock has undoubtedly been subjected.

"THE Geology of the Country between Atherstone and Charnwood Forest" is the title of a geological survey memoir by Mr. C. Fox-Strangways, just published in explanation of the map No. 155. The pictorial frontispiece illustrates the Hanging Rocks at Woodhouse Eaves, one of those crags of sharply pointed rocks which characterise Charnwood Forest, and in some instances suggest resemblances to the kopjes of British South Africa. These ancient pre-Cambrian rocks have been studied in detail by Prof. W. W. Watts, who contributes a chapter on the subject confirming the main results attained by Prof. Bonney and the Rev. E. Hill, and adding much in the determination of an orderly succession. Mr. Strangways contributes chapters on the Stockingford Shales of Cambrian age, on the Coal-measures of parts of Warwickshire and Leicestershire, with illustrative sections and records of borings and sinkings, and on the newer deposits, Permian and Trias, Glacial and Recent. In an Appendix there is a list of works on the geology of Leicestershire, which has been compiled by Mr. Strangways with the aid of Mr. Whitaker.

TO the *Proceedings* of the Philadelphia Academy (1900, pp. 568–581) Mr. H. A. Pilsbry has recently contributed a suggestive paper on the genesis of the faunas of the middle Pacific islands. The land mollusca of these islands form the basis of the discussion, which is formulated by the author in the following words:—"Are the Mid-Pacific snail faunas witnesses to the existence of a palæozoic or early mesozoic land mass, probably continental in proportions, and peopled by representatives of nearly all land-snail groups then existing?" A further question is whether this hypothetical continent was connected at a comparatively recent epoch with Chili. It is concluded that the evidence in favour of the existence of such a continent (upon the sunken heights of which the present island-masses, volcanic or coral, have been superimposed) is overwhelming. But both the marine and terrestrial molluscs lend no countenance that this continent was ever connected with America. It is somewhat curious that the author makes no reference to the Gondwana flora, which has been considered by Blanford and others as affording evidence of a girdle of land round much of the globe in low latitudes in palæozoic or mesozoic times.

THE fourth part of vol. lxviii. of the *Zeitschrift für wissenschaftliche Zoologie* contains an important paper by Herr Antonin Stolc on the power of assimilating and producing hydrocarbons by amœba-like organisms, such as *Pelomyxa palustris*. In spite of certain experiments that have had a negative result, the author is of opinion that such a power undoubtedly exists in the species mentioned, as well as in other members of the group, and he refers to the detection by Reinke and Rodewald of glycogen in the tissues of *Aethalium septicum*. To the same issue Herr W. Redikorzew contributes the results of his investigations into the structure of the ocelli of insects and other arthropods. The ocelli are originally formed by a depression in the thick hypodermal layer, in which one of two subsequent modes of development takes place.

PARTS x to xix of "Papers from the Harriman Alaska Expedition," all of which are devoted to the entomological results (including Arachnids), have been received. Mr. N. Banks deals with the Neuropteroid insects and Arachnida, Mr. H. G. Dyar with the Lepidoptera, Mr. O. Heidemann with the Heteroptera, Mr. T. Kincaid with the Sphegoids and Vespoids, while Mr. A. N. Caudell is responsible for the Orthoptera, Mr. T. Pergande for the Aphididæ and Formicidæ, and Mr. E. A. Schwarz for the Coleoptera and the Psyllidæ. The beetles are the group which had been most worked previously; only a single species of Orthoptera was obtained; but in most of the other groups a considerable number of new types were collected.

THE January number of the *Journal of Conchology* contains a list of British Marine Molluscs and Brachiopods, prepared by a committee of the Conchological Society. This is a good start for the new century, the nomenclature having been thoroughly revised and brought up to date. Some of the names, such as *Neptunea antiqua* for the red whelk, may be unfamiliar and strange, but it is to be hoped that in future they may, for the sake of uniformity, be adopted by all.

ADDITIONS to the British insect fauna continue to be made from time to time, the *Entomologist's Monthly Magazine* for January recording two kinds of saw-flies as new to our islands, while it also gives a list of species of beetles added to the list during 1899 and 1900.

REVIEWING the recent report on the working and results of the Woburn Experimental Fruit Farm, Dr. Maxwell Masters suggested (p. 178) that it would be an advantage to make a corresponding series of growths on poor soil, so as to afford a basis for comparison. We now learn that such a control station has been established already on a relatively barren soil; but the

installation is too recent to allow any definite inferences yet to be drawn.

MESSRS. W. N. BRUNTON AND SON, Musselburgh, N.B., have issued a new list of special brands of electrical resistance material. Taking the electrical resistance of copper as unity, the resistances of wires supplied by the firm are given as follows: Pure Swedish iron, 6; soft steel, 8; Edina steel, 12; German silver (19 per cent.), 17; German silver (28 per cent.), 26; Ferno, 30; and Beacon, 51.

MESSRS. CHAPMAN AND HALL have published a second edition, with appendix, of a book by Mr. F. Hovenden, bearing for its title the interrogations "What is Life? or Where are We? What are We? Whence did we come? and Whither do we Go?" Mr. Hovenden explains how he is able to answer these questions and revise the accepted opinions of men of science.

A SHORT account of the scientific work accomplished by the Tasmanian Society and the Royal Society of Tasmania, from the year 1840 to the close of 1900, has been prepared by Mr. Alex. Morton, the secretary of the latter society. The total number of scientific papers published by this society during the period mentioned, and not including small papers on various subjects, is 606. Of these no less than 132 are devoted to geology, palæontology and mineralogy, 85 to botany, 56 to astronomy and meteorology, and 53 to fishes. Mr. Morton's record is an interesting history of scientific activity in Tasmania, and it is a good testimonial to the valuable work of the Royal Society at Hobart.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from the Andaman Islands, presented by Lieut.-Colonel G. M. Prichard, I.S.C.; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Mr. W. R. Fowler; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mr. E. Thomas; seven Verreaux's Guinea Fowls (*Guttera edouardi*) from East Africa, presented by Mr. J. F. Walker; two Crested Pigeons (*Ocyphaps lophotes*) from Australia, presented by Mr. W. L. Prentice; two Blue-winged Sivas (*Siva cyanoptera*), a Silver-eared Mesia (*Mesia argentauris*), a White-capped Redstart (*Chimarrhornis leucocephalus*), a Rufous-bellied Miltava (*Miltava sundara*), a Burmese Roller (*Coracias affinis*) from India, presented by Mr. E. W. Harper; three Painted Snipe (*Rostratula capensis*) from India, presented by Mr. Frank Finn; a Heron (*Ardea cinerea*) from South Africa, presented by Mr. J. E. Matcham; three Delalande's Lizards (*Nucras delalandi*), a Hispid Lizard (*Agama hispida*), a Three-streaked Skink (*Mabina trivittata*), a Rufescent Snake (*Leptodira hotambaeia*), a Lineated Snake (*Boodon lineatus*) from South Africa, presented by Mr. J. D. Waley; two Green Monkeys (*Cercopithecus callitrichus*) from West Africa, three Viscachas (*Lagostomus trichodactylus*) from Buenos Ayres, three Open-bills (*Anastomus oscitans*), four Starred Tortoises (*Testudo elegans*) from India, a Blue-crowned Hanging Parrakeet (*Loriculus galgulus*) from Malacca, ten Small-scaled Mastigures (*Uromastix microlepis*) from Persia, a Common Toad (*Bufo vulgaris*), European, deposited.

OUR ASTRONOMICAL COLUMN.

ELEMENTS OF COMET 1900 (*c*).—A circular from the Centralstelle at Kiel gives the elements of this comet, computed by H. Kreutz and J. Möller from observations on December 24, 26 and 28, 1900

$$T = 1900 \text{ Dec. } 2{\cdot}660 \text{ M.T. Berlin.}$$

$$\left.\begin{aligned} \omega &= 178°\ 0'{\cdot}8 \\ \Omega &= 192\ 28{\cdot}3 \\ i &= 30\ 25{\cdot}4 \end{aligned}\right\} 1900{\cdot}0$$

$$\log q = 9{\cdot}99184$$

The brightness of the comet is slowly decreasing. The latest observation recorded is by Aitken at Lick, the position being:—

$$\left.\begin{aligned} \text{R.A.} &= 23\text{h. } 23\text{m. } 18{\cdot}5\text{s.} \\ \text{Decl.} &= -23°\ 7'\ 27'' \end{aligned}\right\} 1900 \text{ Dec. } 28.$$

Ephemeris for 12h. Berlin Mean Time.

1901.	R.A. h. m. s.		Decl. ° ′		Br.
Jan. 10	0 36 30	...	−22 44·0	...	0·68
11	41 51	...	22 36·8		
12	47 7	...	22 28·9		
13	52 20	...	22 20·4	...	0·60
14	0 57 29	...	22 11·3		
15	1 2 34	...	22 1·6		
16	7 36	...	21 51·4		
17	1 12 33	...	−21 40·6	...	0·53

NEW VARIABLE STARS.—Three more variables have been recorded as discovered in 1900, bringing the number for the year up to twenty-three (*Astronomische Nachrichten*, Bd. 154, No. 3678).

21.1900, *Monocerotis*.—Prof. W. Ceraski, writing from Moscow, announces the variability of the star situated at

R.A. h. m. s.		Decl. ° ′ ″	
6 48 49·13	...	+11 25 37·0	(1855·0)
6 51 19·24	...	+11 22 21·6	(1900.0)

The brightness varies from 8·8 to 11·5 magnitude.

22.1900, *Cygni*.—Mr. A. Stanley Williams, from examination of photographs by Prof. Max Wolf and himself, has detected variability in the star B D. + 42°·3935, having the position

$$\left.\begin{aligned} \text{RA.} &= 20^{\text{h}}\ 54^{\text{m}}\ 45{\cdot}9^{\text{s}} \\ \text{Decl.} &= +\ 42°\ 2'{\cdot}0 \end{aligned}\right\} (1855{\cdot}0).$$

The magnitude varies from 9·5 to 11·0. A table of observations from 1891 is given, from which the following elements for the variable are determined:—

Epoch of Max. = 1900 Feb. 5 + 13d. 315 E,

so that future maxima may be expected on Jan. 17 and 30, 1901. The writer draws attention to the fact that the rise from minimum to maximum is very rapid, a phenomenon previously recorded by Dr. Hartwig in the variable 2.1900 Cygni.

23.1900, *Andromedae*.—Dr. T. D. Anderson draws attention to the variability of the star B.D. + 38°·315, the place of which is

$$\left.\begin{aligned} \text{R.A.} &= 1^{\text{h}}\ 31^{\text{m}}\ 7{\cdot}9^{\text{s}} \\ \text{Decl.} &= +\ 38°\ 36'{\cdot}3 \end{aligned}\right\} (1855{\cdot}0).$$

The variation is from magnitude 9·8 (1900 Oct. 27) to 10·7 (1900 Dec. 15).

VISIBLE SPECTRUM OF NOVA AQUILÆ.—Prof. W. W. Campbell, during the autumn of 1900, made an examination of the spectrum of the new star in Aquila, which had been discovered by Mrs. Fleming in July, 1900. A 60° simple prism spectroscope was used in connection with the 36 inch Lick refractor. Prof. Campbell confirms the Harvard College observations as to the spectrum being nebular, but mentions differences between it and that of Nova Aurigæ in 1892 which are of importance. The visible spectrum is stated to consist of extremely faint continuous light in the green, and of three bright bands in the positions of the three nebular lines. The relative intensities of the three bands were in agreement with the corresponding intensities in actual nebular spectra. In addition, however, the bands were *not monochromatic*, but on the contrary were *very broad*, perhaps fully twice as broad as in the nebular spectrum of Nova Aurigæ in 1892.

NORMAL POSITIONS OF CERES.—Prof. G. W. Hill has collected the available observations of the minor planet Ceres for the past century during which it has been known, and formed normals from as many as were suitable. The computed normal positions are given for seventy-five years, the dates being for Greenwich mean noon, the values of the co-ordinates being *true*, not apparent. The planet has been observed at every opposition since its discovery, but on two occasions the reductions are discordant (*Astronomical Journal*, No. 487, vol. xxi., pp. 51–54).

THE PANORAM KODAK.

EVER since the year 1845, when Friedrich v. Martens, a copper-plate engraver living in Paris, constructed a camera with a rotating lens and arrangements for a curved plate for taking panoramic views, this method of working has engaged the attention of photographers. Martens's apparatus was designed for Daguerreotype plates, but the convenience of flexible films for such work must very soon have been appreciated, for in 1850 we find Fox Talbot taking the trouble to state that one of his sensitive papers was particularly well adapted for the purpose.

M. Garella, in 1857, employed a flat plate moving tangentially to the required curved surface as the camera rotated, and so obviated the necessity for the curving of the sensitive surface. Messrs. J. R. Johnson and J. A. Harrison worked on similar lines when they produced their "pantascopic camera" in 1862, and its subsequent improvements. These and several other inventors suffered from the disadvantage of having to use glass plates which, whether flat or curved, were awkward to manipulate, and if curved were costly and especially troublesome. Still, very excellent work was done with these apparatuses.

Modern panoramic cameras date, practically speaking, from the commercial preparation of flexible or film-supported sensitive surfaces. Commandant Moessard, in 1893, employed a curved film supported in a curved celluloid holder, while M. J. Damoizeau (1891), in his "cyclographe," and Colonel R. W. Stewart, R.E. (1893), in his "panoram," employed films in the most compact way possible, drawing the film from one roller to another as the camera rotates. Colonel Stewart's camera is very small for the size of picture that it takes, and will, if required, photograph the whole horizon at one operation. He constructed his apparatus for Eastman's films.

But all these cameras were, comparatively speaking, costly, heavy and complicated, being actuated by clockwork or the equivalent, and the later examples were designed to be applicable to photographic surveying. No one appears to have considered it possible to construct a panoramic camera that should be light and simple in construction, and so available for the ordinary tourist, until the enterprising firm of Kodak, Ltd., introduced their "panoram kodak." In this camera they have not only succeeded to this extent, but have provided what is commonly understood as a "kodak"—that is, a camera that may easily be held in the hand during the exposure. Its construction is very ingenious in its simplicity. During exposure, the only moving part is the lens, which swings on a vertical axis, and the only motive power is a spring. The spring acts on a lever, and as the arrangement is laterally symmetrical, the exposure can be started from the side that the lens happens to be pointing towards. There is no shutter as ordinarily understood, the lens revolves through a half circle, and at each end of its journey is accommodated in a little recess that prevents any light passing through it to the inside of the camera.

The sensitive surface is the roller film, which passes over guides that maintain it at the correct curvature. The picture produced is seven inches long and 2¼ inches high, and the definition is good over its whole length, showing that the difficulty of the correct adjustment of the swinging lens has been quite satisfactorily overcome. As already stated, the apparatus is of the simplest kind. The lens works always at the same aperture. It has two rates of movement, the equivalent of two speeds of a shutter, effected simply by putting the full or a partial tension on the spring. But long exposures can be given by just repeating the ordinary exposure as often as necessary, the camera, of course, being firmly supported. We have seen some excellent views of dark wooded scenery taken in this way.

It may be worth while to remind those who think that they would appreciate the possibility of getting views including a wide horizontal angle, that the perspective of the pictures produced by all such apparatus as that referred to is cylindric, and, being different from the more usual plane perspective of flat plates, requires different precautions on the part of the photographer to avoid unpleasant results. The chief of these precautions is due to the fact that horizontal lines that lie either above or below the axis of the lens are curved towards the axis. The horizon itself is, of course, never curved on the photograph if the camera is level, and the panoram is provided with a spirit level as a guide for this purpose. Speaking practically, the one kind of view to avoid may be exemplified by a long building photographed from a point approximately opposite to its centre, facing it, say, from the other side of the street. It is impossible by any means to set a satisfactory representation of such an object from such a position, but the temptation to make the attempt is greater with a panoramic camera than with the more usual apparatus.

Now that a panoramic camera suitable for ordinary purposes has been shown to be possible, we hope that the construction adopted will be applied to the production of other sizes and perhaps other qualities of apparatus.

C. J.

SOME RECENT ADVANCES IN BIOLOGICAL SCIENCE.[1]

A TIME-HONOURED distinction has been drawn between the so-called observational and the experimental sciences; and, pledged as we are to the former, we have to deal with those subjects which, in the hands of the immortal Darwin, have during the last forty years revolutionised all departments of science not wholly mathematical, for be it remembered that the formulation of the periodic law in chemistry is but that of an evolutionary hypothesis. So reactionary has been this influence upon thought and mental conduct, that it has rendered it impossible for us to think as did our forefathers, and has thereby increased our responsibility to our juniors and those who seek our guidance.

Never was progress more rapid than in these post-Darwinian days. Steady work in the discovery and classification of genera and species has proceeded all along the line, and with extending influence in the far East. Some idea of what is now taking place in our chosen field may be formed from the fact that, since the adoption of western methods by the Japanese, we have not only to record zoological discoveries of first-rate order, due to the fact that they alone possess the material upon which they are based, but to their lasting credit be it said that they have put us right on fundamentals upon which we have for generations imagined we knew all. To wit, a young Japanese, Hirota by name, alas, now dead! availing himself of the discovery by his teacher of a peculiar condition of the egg-membranes in the native tortoises, was led to argue that since these creatures and birds are not so very distantly related, the like might be forthcoming in them; and turning to the common chick—the bird most ready to hand—he succeeded in proving not only the existence of the condition suspected, but that we in the West, with our boasted methods and resources, by error of orientation, contenting ourselves with the mere examination of parts, instead of the whole object, have gone wrong on an elementary and most important detail.

One immediate effect of the demonstration of the truth of evolution, now historically established, has been the substitution for the old-fashioned and merely tabular classifications of animate beings, of linear arrangements and phylogenetic trees. To those of the Hæckelian school, fired by an energy of enthusiasm, it appeared easy to locate every known creature to its proper place in the series; but while these persons did good by the stimulating influence of their work, it is needless to say that the hasty construction of such schemes must be fraught with error. So colossal a task is not to be achieved in a lifetime, and it too soon became evident that these fantastic expressions of supposed facts, like all classificatory formulæ, had to give way under the growth of knowledge, until now the time has come when our classifications of animals, which, be it said, are at best but the tentative expression of our ideas, are being based, not on the mere characters of the exterior, or of a single series of parts, but on the sum total of the maximum number of characters observable. Where we once thought we detected relationships, we now know we were often being misled, and the old-time supposition that mere community of structure is necessarily an index of community of origin has gone to the wall.

The past three decades will be ever memorable in the history of biology as that of what may be termed the embryological reaction, prompted by the thought that the clue to the origin of an animal in the remote past lies in the study of its development from the egg, believed to recapitulate the history of its race. Great, however, has been the disappointment in this respect, it having been discovered in many cases that the animate being,

[1] Abridged report of the Presidential Address, delivered by Prof. G. B. Howes, F.R.S., before the South-Eastern Union of Scientific Societies, at their Fifth Annual Congress, held in Brighton.

during its development, is so liable to adaptive change of but passing significance, that it becomes difficult to distinguish between this and the historic record originally believed to be passed through. But, that notwithstanding, upon data of this order many of our recent conceptions of the origin and succession of animal forms have been built up; and it is clear that if, on the basis of such facts, we attempt to deduce those generalised statements we term "laws," the test of our accuracy lies in appeal to the fossiliferous strata, in which we ought to find evidence of their presumed operation in the past. Here I am led to emphasise the importance of the study of palæontology, and, as bearing on the argument deduced from that of development, a striking outcome of recent palæontological investigation has been the unearthing, in the United States of America, of perfectly preserved remains of the Trilobites, the oldest and most primitive of all Crustacean forms. These creatures are now proved to have been possessed of but one pair of antennæ, there being two pairs present in every ordinary later member of the Crustacean class. It so happens, however, that this is the case for the adults only, and that the presence of but a single pair is characteristic of the larval stage through which all freely developed Crustacea pass, and, from what is now known of the details of the appendages of these Trilobites and the said Crustacean larvæ, there can be no doubt that in this particular class of animals the larva is realistic in its characters of the remote ancestor from which, in past ages, its members have been derived.

Other memorable instances have come to hand in the study of the palæontological record, which have profoundly modified our conceptions of the succession and primary relationships of animal forms. For example, evidence is now accumulating that in the case of birds the remote ancestors were of a more primitive reptilian stock than has been until recently supposed. Again, those structural features in respect to which the living Batrachia simplify the reptilian type are now coming to be recognised as largely due to retrogressive change, and we are beginning to see that both these classes of animals in all probability converge towards an assemblage of palæozoic forms, combining the characters of the two as to-day represented, and that the older naturalists, in classifying the cold-blooded terrestrial vertebrata together, were perhaps not so far out as we have been prone to think. A wonderful chapter has quite lately been added to the history of the horse, by the discovery in South America of an equine animal which possessed the single toe and other features familiar in it. The race to which it belonged has apparently become extinct only in quite recent times, and when we picture to ourselves the course of events to which it points, we conclude that in early Tertiary times the ancestors of the horse tribe, arising in Central America, migrated into the Old World, on one hand, and into South America on the other; and in each, by independent but parallel differentiation, gave rise to an essentially similar definitive form. Survival of this in the Old World alone has resulted in the horses of to-day, those now living in America having been secondarily imported by man.

The case in some respects recalls that of the pig tribe, except that, with this, migration in opposite directions has been accompanied by diversity of modification. Originating in early Tertiary times in Central North America, their ancestors migrated on one hand into the Old World, and by complication of their teeth gave rise to the swine and hogs of later times, while on the other hand, passing into the southern parts of America, they by numerical reduction of their teeth and toes gave rise to the peccaries of to-day.

Taken in conjunction with the now well-recognised fact that certain animals which in life and in all superficial features resemble each other can be proved on examination of more deeply-seated characters to be genetically distinct, this consideration raises the question of the importance of what is known in nature as the phenomenon of "Convergence." We now know of creatures externally almost indistinguishable from slugs which have the internal anatomy of snails and of slugs occurring independently in different parts of the world which exhibit a repetitional similarity of relationship to the snails of their respective areas; and we have long been familiar with a Crustacean—the "King Crab"—living on the opposite shores of the North Pacific, which, in respect to the segmentation of its body and the number and characters of its limbs more especially, conforms to the Scorpionid type. Numerous other instances might be cited, but these are sufficient, and the question for consideration is, how far such superficial resemblances, in that they have led to the association of forms in which they occur in a common classification, are trustworthy as criteria of affinity. The case for the King Crab and the Scorpion is one of long standing, and there is reason to believe it is still open to doubt. In all groups of Arthropods, to which both creatures belong, we meet with forms in which the familiar free body-rings or "segments" are for the greater part united, and others in which they are free, and there can be no doubt that the degree of union of these, which takes place in definite antero-posterior succession, is a sure index of "highness" and "lowness" in a given series—those in which few segments unite being low, those in which many unite, high. To this process of fusion of body-segments our American *confrères* apply the expressive term "cephalisation," and, when this test is applied to the two groups to which the animals in question belong, it is found that, in respect to it and certain correlated modifications, they each stand at the summit of their respective series—*i.e.*, that there are, among the "spiders," forms which, at least as regards cephalisation, simplify the Scorpionid type along lines parallel with those in which the so-called Eurypterids of the past, in this and other respects, simplify the King Crab type; and when, further, it is found that among the fossil Scorpions known there are indications of simplification of exactly the order the facts would lead us to suspect, it follows that King Crab and Scorpion of to-day each hark back to a distinct and independent assemblage of forms. With this, the association together of the culminating types, as in most of our current classifications, becomes dangerous, if not misleading; and we are brought to the realisation of the fact that mere community of adult structure does not necessarily imply community of origin, and that by a parallelism of modification two creatures of diverse ancestry, in adaptation to the conditions of life, may, independently, and by "convergence," assume a similar form.

The approximate resemblance between the crowns of the teeth of the horse and ox is a familiar example, and we have evidence that in this way certain types of teeth represented among the living mammals, by which these are still classified, have been anticipated by totally different groups in past periods of time; and if we are to trust recent research, teeth already modified along lines anticipatory of the carnivorous and herbivorous types of to-day co-existed in an assemblage of supposed cretaceous mammals of South America whose affinities are as yet not fully established.

The extent of the operation of "Convergence" in nature's work is but now becoming recognised, and there is proof to hand that many of our time-honoured classificatory systems are erroneous, by failure of its appreciation in the past. Impressed by this, it behoves us to reflect to what an extent nature's plans, so to speak, have, in the history of organic evolution, as in that of civilisation, repeated themselves, she being apparently intent on a recurrent diversity of differentiation, for some purpose associated with the balance of life we do not understand, as in the fact that when, in Mesozoic times, she had but the reptiles upon which to operate, she produced terrestrial, aquatic and flying forms, just as, in later periods, she has produced them with the mammals, which replaced these in order of time.

Again, with the development of the Darwinian doctrines, there early arose the realisation that, on the principle of descent with modification, the summary appearance of organs having no existence in near allies, either during the development of certain species or on the assumption of the adult state, presented a difficulty which even Darwin himself, ever more justly critical of his own work than many of his would-be opponents, clearly admitted. The independent appearance of luminous organs and those of electrical discharge in remotely related groups of fishes are ideal cases, at first sight calculated to break the back of the rigid Darwinian. Some thirteen years ago, Dr. Anton Dohrn, of Naples, and the late Prof. Kleinenberg, of Messina, formulated the doctrine of "Substitution of Organs," which provides that under varying conditions of life, and at different periods of development, sets of organs may replace others, to the better fulfilment of the life of the individual or race. To apply this to the case of the organs of electrical discharge in fishes in no way closely related, let it be said that our commonest rays and skates are possessed of such an organ, located in the tail. The peculiar feature of these fishes is the usurpation by their expanded side-fins of the propelling action, which, in ordinary fishes, is performed by the tail. What more

reasonable, therefore, when we know these rays and skates to have been derived from heavy-tailed shark-like ancestors with small side-fins, than the question how far conversion of the tail into an organ of electrical discharge may not have been the outcome of the taking-on by the side-fins of the swimming function? The answer to this is convincing and complete, for we find among the tropical and more distant allies of these rays, that the tail may become by elongation in one species a delicate trailing whip-lash; by abbreviation in another a mere vestigial stump, or by the addition of spines in yet another a formidable weapon of offence. Clearly, rid of the propelling function, it has become free to modify its ways, and the conversion into an organ of electrical discharge is found to be but one of a series of independent adaptations by "substitution."

Other and more beautiful examples of the working of this law might be cited, such, for example, as that of the provision for "casting" the tail, so well known among living lizards; but sufficient is before us to show in what manner the advance of knowledge dispels our difficulties, and that the stumbling-block of one generation may become the stepping-stone of the next.

If evolution—defined as the law of descent with modification, and involving the process of progressive advancement and passage with time from the simple to the more complex—is all sufficient to explain the existence and succession of the diverse forms of life, it might well appear that the conditions of modification are more complex and less regular than would have been expected; and we are, therefore, led to inquire in what the determining cause of modification and hereditary tendency may perchance consist. Looking back on the history of biology, three great names stand out above all others as those of the pioneers in its turning-points, Linné, Cuvier and Darwin. Linné taught us how to name and describe the objects in nature; Cuvier impressed upon us the fact that unity of structure underlies the great diversity in superficial form; Darwin, for the first time, furnished the clue to this unity, on the lines to which I have already referred, and showed us that vital phenomena are attributable to the working of a fixed set of laws.

It may be said of all living things that, so far as their bodies consist of a mass of living substance, which we term protoplasm, they are structurally identical. In seeking to classify them, be they plants or animals, the sharpest working distinction to be drawn is between those which consist of one structural unit or are unicellular, and those which consist of an aggregate of units or are multicellular—hence our terms Protozoa and Metazoa, Protophyta and Metaphyta, or collectively Monoplastids and Polyplastids, the term "plastid" being sometimes substituted for "cell." While the monoplastids, mostly though by no means all visible only under a lens, consist each of but one cell, one structural unit, of the order of those which in the aggregate compose the body of the polyplastid, there is no fundamental difference recognisable in the manner and extent to which multi- and uni-cellular beings stand related to the universe at large. Both are motile and sensitive; both produce waste, by processes which unchecked lead to decomposition and death; both stand, therefore, in need of recomposition and must be nourished; and both are loyal to the divine command to increase and multiply. It is concerning this reproductive process that the post-Darwinian period has witnessed an altogether unparalleled activity, in the attempt to get at the essence and to unravel the mystery of hereditary influence. The mental giant who has led the way is Prof. Weismann, of the University of Freiburg, in Breisgau. His whole series of doctrines find their focus in three epoch-marking addresses, which he delivered in 1881–1883 before the Association of German Naturalists and his University, entitled "On the Duration of Life," "On Heredity" and "On Life and Death." He took his stand upon the well-known fact that whereas reproduction of the unicellular organism is by a simple process of fission, the individual dividing into two without loss of substance, and becoming at once parent and offspring—in the multicellular organism the reproductive act involves only an insignificant portion of the body, and is sooner or later accompanied by the death of that which remains, and a consequent loss of substance. From this he argued that inasmuch as it is conceivable that the fissiparous process may go on indefinitely, the Protozoan of to-day may have arisen by repeated and prolonged fissiparous activity from that of long passed ages, and that the organism, never having suffered a loss of substance, may be immortal. Founding, in this way, his doctrine of the "Immortality of the Protozoa," he was led, by realisation that that portion of the body of the multicellular organism which fulfils the reproductive function passes to its share in the formation of a new individual a living element, to distinguish between it, the "germ-plasma" which never dies, and the rest of the body or "somatoplasma," which is lost by decomposition and death, and he in this way sought to extend the conception of immortality to the reproductive elements of the higher organisms.

This marvellous generalisation—prettier far than poetry—created in the early "nineties" a veritable furore; and it furnishes us with material for reflection and mental consideration of an altogether unique order. So profound, however, was its effect upon contemporary science and thought, that under its influence there arose a horde of eager investigators, intent on its development and the search for the seat of primary hereditary influence. The literature and vexed controversies which have in consequence arisen are now voluminous, and Weismann and his followers, eager to push forward, have pressed theory upon theory, often with contradictory effect. His whole series of observations, however, focus in the afore-named great generalisation, and, as for alleged contradiction, I can only regard it as due to the influence of his friends, who, eager for his advance, and perhaps, in the case of some, for association with his work, forced him to extremes which he would never have contemplated had he been left alone.

As might be supposed, the conception of the immortality of protoplasm has not passed unchallenged. Maupas, an acute French investigator, has discovered of the familiar "Bell Animalcules," that prolonged fissiparous reproduction is accompanied by progressive diminution in stature, leadin , if unchecked, to senility and decay; and, having determined by observation the number of generations in which this veritable extinction may be brought about, he has succeeded in proving that, by means of a conjugative process, involving a blending of two individuals, its effects are overcome. To what this remarkable discovery may ultimately lead we know not, but it so happens that, whether the conception of immortality be right or wrong, it arose in the minds of trained naturalists long before Weismann's time. He himself starts with a quotation from Johannes Müller, the founder of comparative anatomy, to the effect that "organic bodies are perishable, and that, while life maintains the appearance of immortality, in the constant succession of similar individuals, the individuals themselves pass away." And similarly, R. Owen, in two great lectures on "Parthenogenesis," delivered before the Royal College of Surgeons, in 1849, came nearer the mark, with the astounding paragraphs:—

"Not all the progeny of the primary germ-cell are required for the formation of the body of all animals; certain of the derivative germ-cells may remain unchanged, and become included in that body which has been composed of their metamorphosed and diversely combined or confluent brethren. So included, any derivative germ-cell . . . . may commence and repeat the same processes of growth and imbibition, and of propagation by spontaneous fission, as those to which itself owed its origin, followed by metamorphoses and combinations of the germ-masses so produced, which concur to the development of another individual, and this may be, or may not be, like that individual in which the secondary germ-cell or germ-mass was included."

And, concerning the conception of immortality of the Protozoa, he also wrote:—

"It is by no means easy to find a name for the relation in which the fissiparous monad stands to the two monads between which it has been equally divided. A parent retains its individuality distinct from its progeny; but the monad has become a part, and indeed the chief part, of the two that have resulted from its spontaneous fission. Both separate moieties are, in an equal degree, the same individual as the whole from which they proceeded; and in an infinitesimal, though conceivable, degree, the actual monad is the same individual as the first created one, from which it may have proceeded by an uninterrupted succession of spontaneous fissions, and in that degree it may be viewed as one of the oldest known individuals in creation, the individual being never wholly or in part deceased."

Not that this in any way detracts from the merits of Weismann's labours! On the contrary, to him is due the credit of having put the vitally important topic which now concerns us on a scientifically sound and workable basis—an achievement of which he may well be proud.

It being evident that the unicellular and multicellular organisms stand alike responsible to the universe at large concerning

their functional activities, we are led to inquire in what way the localisation of these in the higher and compound forms may have come about. "Differentiation of labour" is the popular explanation, and one is prone to ask whether the structural or the functional differentiation was first achieved. It has generally been taught in the past that the structural preceded the functional, but we are now coming to doubt this long-cherished conclusion, in evidence of the fact that nature will, with equal facility, effect corresponding differentiation for the fulfilment of the same end, in either the whole body of a unicellular organism or a localised part of a multicellular one—in either a single cell or a cell-aggregate—as, for example, in the formation of what are known as the ciliated membranellæ of the Infusor *Stentor*, and the so-called corner-cells of the Mollusc *Cyclas*. Differentiation depends, not on the interaction of cells, but upon the elementary structure and potentialities of protoplasm, or, as Prof. C. O. Whitman, of Chicago, has expressed it, "organism precedes cell-formation."

If this be so, there is raised the question how far the idea, developed during the past two decades, that the animate being is a mere blind automaton, and its actions but complicated functions of a chemico-physical order such as we deduce from the study of the inanimate, is correct, and we are prone to inquire if the structural units of the animal body are, so to speak, bricks set to a mathematical relationship, controlled by laws of pressure, or living units, capable of working to their own ends, and defying mechanical conditions such as apply to the inanimate.

It has long been said of us devotees to the observational branches of science that our methods are inaccurate by lack of qualitative treatment, and the distinction has been drawn between ours, the so-called "inexact," and the mathematical or "exact" sciences. On this basis there are now being pushed forward attempts to apply statistical, experimental and mathematical tests to the study of vital phenomena. All honour to those who are making them, for it is certain there are phases of life capable of mathematical treatment, but the mystery of life can never be thus solved; and, concerning the objection to the observational method, I would remark that if by that we are to understand observation, with confirmation and generalisation, and rejection of the non-confirmable, our non-mathematical procedure is scientific. Huxley has long ago said of mathematics that what you get out of the machine depends entirely upon what you put into it.

Ten years ago, any one asked to define the nature of the primitive organism from which all organic beings are descended, having regard to then known chemical phenomena of life, would most certainly have argued in favour of a green-plant, or of some organism capable of decomposing CO_2 under the action of sunlight, and of raising inorganic substances to an organic level, thereby rendering them fit for animal food. We now know of the existence of lowly organisms capable of decomposing CO_2 in the absence of chlorophyll. The ploughing in of the roots of certain leguminous plants, in which our German cousins have been for years ahead of us, is now well known to be associated with the presence of fungi, capable of assimilating the nitrogen of the soil. In the nitrifying bacteria, we are now familiar with organisms by whose aid ammonia becomes the origin of nitrates and nitrites, and there are others which, by a process of denitrification, effect the reduction of these, with liberation of free nitrogen. And startling indeed is the knowledge that there exist in certain seas, and, it may be, near our very doors, bacteria which possess the marvellous power of decomposing sulphates, and of living in an atmosphere of sulphuretted hydrogen. The discovery that certain lowly fungi are so sensitive to chemical change in their nutritive media, that the presence of one part in 50,000 of zinc chloride will act as a powerful stimulus, and produce a growth some 700 times its own initial weight, and that one part in 1,600,000 of silver nitrate is abruptly fatal to it, is simply astounding.

Turning to the animal, we find that whereas in the case of the hot-blooded rabbit the weight of oxygen per hour sufficient for the maintenance of life is as 2·284, in the case of the cold-blooded American turtle it falls to 0·088. With the animal, as with the plant, so sensitive are the parts of the body to variation in chemical composition of fluids with which they may be brought into contact, that, under conditions of experiment, it has been found that the heart of a frog, of which the beat has been lessened or arrested by treatment with salt-solution or distilled water, may be revived by the accession of one part in 10,000 of calcium carbonate.

What all this means, regarding the processes involved in the mystery of life, and in what direction it is leading us, the future can alone sufficiently show. One thing is certain, that since living matter in all its forms is constantly undergoing waste and disintegration by oxidation, life is possible only under a penalty of death, and we are prone to inquire if this is a mere chance circumstance or a necessity to some beneficent end. We know that in the order of evolution the simpler forms of plants and animals have, by combination and advancement, given rise to the more complex, and it is clear that if this process were to go on indefinitely, a time might come at which all the simpler forms would be used up, and life would cease. The breaking up of the complex forms and the dissociation of their elements, however, results in the return to mother earth of the raw material of which they are composed, and thereby renders possible the repetition of the cycle, and from this it follows that the destruction of the individual may have been really a necessity, in order that others might live.

In this consideration we are once more brought into touch with inorganic nature, and it is a remarkable fact that the very chemical elements which enter into the composition of the simplest protoplasmic structures are precisely those contributing to the formation of the simplest of chemical substances, so far, at any rate, as hydrogen, oxygen, nitrogen, sodium, calcium, magnesium and iron are concerned. My friend and colleague, Sir Norman Lockyer, has recently emphasised this consideration, and, with a boldness worthy his great reputation, has dared to discuss the significance of the facts. The spectroscopic analysis of the hotter stars has revealed to him the truth that their simple chemical constitution is explained by the fact that the final products of dissociation by heat are the earliest chemical forms. From this he deduces the conclusion that with the heavenly bodies, as with the organic world, the simplest forms appeared first, and that the dissociation stages of the former, as of the latter, reveal to us the forms the coming together of which has produced the thing dissociated or broken up. Passing from the hottest to the cooler stars, he argues that, like the various geologic strata, these bring before us a progression of new forms of increasing complexity in an organised sequence, and, developing this pregnant line of thought, he reverts to the uniform simplicity in chemical constitution of the earliest inorganic and the primitive organic forms, and deduces the belief that "the first organic life was an interaction, somehow or other, between the undoubted earliest chemical forms." It is a far cry from the primitive monad to the hottest star, but so convinced is Sir Norman Lockyer of the analogy between the methods of organic and inorganic evolution, that he has used the latter term as the title of his book, which I can strongly recommend to your earnest consideration. We advance by facts, we live by ideas, and if Sir Norman Lockyer's fascinating theory does no more than set the trained mind to work and arouse interest in the topics with which it deals, it will have served its purpose.

To turn now to the physical properties of living matter. Concerning the eye, it may be said that in the contraction of its retinal pigment by a vital act in definite response to the rays of the spectrum, and in the falling to a focus, within the substance of the crystalline lens, of the inverted image formed by that, it is neither constructed nor behaving in the manner of the inanimate photographer's camera, with which it has been *ad nauseam* compared! Again, the discovery in recent years that whereas, during life, the gaseous diffusion of respiration does not take place in strict conformity with the laws applying to inanimate membranes, it does so after death, with that of the changes and processes undergone by the food in its passage through the intestinal wall, now proved to be of no mere mechanical order, testify to the conclusion that the moment you bring the conditions and arguments deduced from the study of the inanimate to bear upon what may be expressively termed the animate organic membrane, they either do not apply or are set at defiance.

Many other examples might be cited. We are getting back to a conception of a "vital force," not of the order of the ancients—a "Psyche"—a mysterious controlling influence beyond our ken, but one which we may term a *Neo-Vitalism*, which teaches us that although organic matter is in its manifestations chemical and physical and the basis of life is associated with chemical and physical processes, the physics and chemistry are not those of the inanimate as at present understood, and gives us hope of its discovery if we will but persevere.

Finally, as to the charge of inexactitude. It is one of the

blessed aspects of the study of animate nature that there may be the alternative interpretation. Work at a problem long as you will, you will find that when you flatter yourself you have obtained the clue to its significance it will often happen that it is just that which you have missed.

Call it ambiguity if you will; it is primarily due to the structural and functional complexity of living matter, and there lies in it, to my mind, the greatest charm of our science, in that it appeals to the imagination, and therein arouses one of the highest of the intellectual faculties. We work in hope, content to investigate the reason of phenomena, but the nature of things will be ever beyond our grasp.

As contributing to the advancement of knowledge, and to a fuller understanding of the phenomena which underlie the operations of nature, the topics to which I have drawn attention are among the most important in the recent progress of science —the most revolutionary results of patient, persistent inquiry. In their definitive form, the so-called "laws of nature" are but generalised statements of fact, and, so far as we are individually concerned, I would remind you that, since we are but members of the great animal subkingdom, dependent, with the probable millions of species which compose it, upon a common set of conditions in our relations to the universe at large, it is impossible, if we would know and appreciate our position in the world, to present a deaf ear to their teaching. It behoves us not only to ponder them on our own account, but to see to it that, as time progresses, those committed to our charge are so brought up as to be not wholly ignorant of them.

And this brings me to the concluding portion of my address.

As members of local committees and scientific societies, we are pledged to the task of what is known as popular education, and its correlate the "popularisation of science." Exactly what this hackneyed expression may be taken to imply I have never yet discovered, and, speaking for myself, I regard it as erroneous. Science cannot be popularised, and any work to-day worthy the name of scientific must be technical. To popularise science is an impossibility, but to popularise the results of it is quite another thing.

Our task is educational, and we have to encourage a love of those subjects which form the basis of the doctrine of "organic evolution," from which has arisen the greatest revolution in thought and the conduct of life the world has ever seen. How heavy the responsibility we thus incur! How poor the encouragement we, for the most part, receive at the hands of our fellow citizens! To the credit of our nation, be it said, the State is now alive to its responsibility in the matter, and to that of our County Councils, that they are doing their duty towards the higher education and science in particular. But I have grave doubts if the best is being done by private enterprise, which in all matters of progress is a characteristically British method of procedure in the higher walks of life. How many of us, competent to aid in the local management and organisation of museums and scientific institutes, are doing all that we might to keep those in charge of them on the right path. One still finds exhibited the *omnium gatherum* of scraps, the product of nature overshadowed by the artifice of man. In place of the representative collection of objects of local interest, of specimens and maps which should furnish a key to the physical constitution of the neighbourhood, and which a visitor has a right to expect on entering a strange land, one too often finds the rumble-jumble of odds and ends, with here and there a hidden treasure. There is a so-called "museum" not many miles from this place, in which payment is extracted from the visitor to behold, as a conspicuous exhibit amidst a collection of oddments, a milk tin recovered from the *Fram*, which Nansen would himself probably disown! Local control and organisation should render this sort of thing impossible, despite its being due to "private enterprise," and you must please pardon me when I draw attention to the fact that we in the south are behind our northern brethren in respect to local organisation for science and the higher education. I can conceive no better outcome of this meeting than that we should at once resolve, by connected action, to put this right.

On appeal to a frivolous public, we are told there is nothing to come of it, that work of the kind to which we aspire is not remunerative, and that the cultivation of scientific tastes is to be avoided, as narrowing in effect and tending to dwarf the religious instinct, and foster doubt. To this I would reply (1) that most of our boasted advantages in civilisation have been due to the outcome and the application of science to daily life and domestic use; (2) that there is no better tonic for the human mind than that afforded by perusal of the works of nature; (3) that the existence of matter, "motion, and law-abiding operation in nature, are greater miracles than were ever recounted by the mythologies"; and (4) that science, with love, now rules the world.

To counteract the tendency of our time, it is for us to see to it that the selection and arrangement of the exhibits in our museum collections shall furnish the visitor with a series of local object lessons, both attractive and instructive, and so ordained as to create in the mind of the mere passer-by—as can readily be done by the excellent system of descriptive labelling now coming into vogue—a desire to know more of his immediate surroundings, and, through them, of his position and relationships as a dweller in the neighbourhood and a factor in the universe at large.

The aim and object of not a few of our local scientific societies would seem to be publication rather than this, and against the tendency I would urge every influence I can command. If confined to mere local records of fact, *Proceedings* or other publications, maintained in moderation, are well and good, but, with larger and central institutions given to the meeting of persons from various localities for comparison of local forms and discussion of broad principles, the local society, in striving after this, is exceeding the bounds of reasonable distribution of labour.

Once again let me remark that we can have no higher object in view than the capture of youth. Huxley has wisely said:—

"The great end of life is not knowledge, but action. A small percentage of the population is born with special aptitude of some sort or another; and the most important object of all educational schemes is to catch these exceptional people, and turn them to account for the good of society . . . and to put them into the position in which they can do the work for which they are specially fitted."

And he added:—

"That if the nation could purchase a potential Watt, a Davy, or Faraday, at the cost of 100,000*l.* down, he would be cheap at the money."

To me nothing would be more gratifying than that there might result from this meeting an agreement upon a line of action which might track a genius and place him on the ladder he was born to ascend, to the permanent glory of his race and benefit of the world at large.

In these days, when bombast and self-assertiveness are apt to be mistaken for executive power, we want all the originality we can secure. Learning is but our knowledge of the experience of others, knowledge our very own! Higher ambition than that of adding to the sum of knowledge no man can have; wealth, influence, position, all fade before it, but we must die for it if our work is to live after us.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A COURSE of lectures and demonstrations in practical hygiene for teachers will be held partly at Bedford College and partly at the Sanitary Institute, on Saturday mornings during the three terms of the present year.

WE learn from *Science* that Mr. John D. Rockefeller has made a further gift of 1,500,000 dollars to the University of Chicago. Of this sum, 1,000,000 dollars is to be used as an endowment fund. The balance of the gift is to be used for general needs. Mr. Rockefeller suggests that 100,000 dollars be used for the construction of a university press building. Mr. Leon Mandel has given 25,000 dollars to the University, in addition to his previous gifts.

ONE of the most important developments recorded in the recent report of the Somerset County Education Committee is the presentation, by Lord Portman, of an experimental farm, five miles from Taunton. The farm consists of 142 acres, of which 80 are pasture. Lord Portman has made considerable alterations and additions to the farm buildings in order to bring them up to date and to adapt them to the requirements of the County Committee. The primary object of the farm will be experiments on the profitable feeding of farm animals of various

kinds. Incidentally there will be considerable opportunity for experiments in the improvement of land and the best methods of growing various crops.

ANNOUNCEMENT is made in the *British Medical Journal* that the rich family of Mitsui of Tokio has offered an extensive site in that city for the erection of a University for women, and three other citizens have between them contributed a sum of 24,000*l.* for the cost of the necessary buildings. The work is already in progress, and it is hoped that the new University will be opened in the spring of 1901. It is not likely that there will be any want of students, as in recent years very many young ladies of good family have applied to be admitted to the University courses, especially to the faculty of medicine and the Polytechnic School. The latter institution is intended for the training of civil engineers, a circumstance which seems to show that Japan is about to set an example to Europe in opening up a new sphere of labour for the women of the future.

THE new Calendar of University College, London, announces several developments for the present year. There will be a course of work in experimental psychology, and an elementary course of physiological demonstrations on the nervous system and the sense-organs. A complete installation for the production of liquid air has recently been presented to the College, and facilities are offered for research at low temperatures. Instruction is given in spectroscopy, which forms a subdepartment to chemistry, and is equipped for practical work in spectrum analysis and spectrum photography. A special course on the morphology of the Sporangium has been arranged, and subdepartments in physiological chemistry and histology have been established. The Calendar contains an important speech delivered by Lord Reay, president of the College, on the development of the University of London ; and lists of original publications by members of the Faculties of Arts, Laws and of Science.

SCIENTIFIC SERIAL.

American Journal of Science, December, 1900.—Torsional magneto-striction in strong transverse fields, by C. Barus. The effect of longitudinal magnetisation is an increment of rigidity in all paramagnetic metals, whereas the permanent effect of a transverse or a circular field is relatively inappreciable so far as rigidity is concerned.—Notes on tellurides from Colorado, by C. Palache. The minerals described include sylvanite from Cripple Creek and two well-developed Hessite crystals from Boulder County.—New species of *Merycochoerus* in Montana, by Earl Douglass. The new species is called *Merycochoerus laticeps*. It has a low skull, broad behind the orbits, and narrowing rapidly towards the front and back. Brain case short, the length behind the post-frontal process being about one-half the distance in front of it. Premaxillaries united in front, forming a trough-shaped depression, evidently for the accommodation of a proboscis. Maxillaries deeply concave on the sides of the face. This, with the malo-maxillary ridge, which widens outward rapidly towards the zygomatic arch, forms a broad and nearly horizontal shelf above the posterior premolars and anterior molars.—Mohawkite, stibio-domeykite, domeykite, algodonite, and some artificial copper arsenides, by G. A. Koenig. In the Keeweenaw copper formation, the arsenides are not found in the bedded deposits of native copper, but always in fissures, intersecting the beds. The veins have thus far only been observed in the lower beds, near the foot of the formation to the southeast. Arsenic, however, is found in the smelted and refined copper of all the mines. The author describes the physical and chemical constitution of the minerals named.—Heat of solution of resorcinol in ethyl alcohol, by C. L. Speyers and C. R. Rosell. Since heat is rejected when resorcinol dissolves in a large excess of ethyl alcohol, and since heat is absorbed when it dissolves in a small quantity, the temperature should not change when these substances are mixed in some certain proportion. This proportion is found to be about six grammes of resorcinol to about 100 grams of ethyl alcohol.—The sulphocyanides of copper and silver in gravimetric analysis, by R. G. van Name. The estimation of sulphocyanides by precipitation with silver nitrate and direct weighing of the precipitate is wholly permissible. The method is extremely simple, and the results are quite accurate.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 6, 1900.—"On the 'Blaze Currents' of the Frog's Eyeball." By Dr. A. D. Waller, F.R.S.

The author demonstrated by experiment on the frog's eyeball the responses to electrical stimuli, which he terms "blaze currents." He gave an account of his work, which is briefly summarised in the following statements. The normal electrical response to light and to every kind of stimuli is positive, *i.e.*, from fundus to cornea ; it is partly retinal, partly by other tissues, it is reversed by pressure. "Blaze currents" are responses to electrical stimuli, and are comparable with the normal discharge of an electrical organ amounting to 0·03 volt. "Blaze currents" manifest summation of stimuli and effects, staircase increase and fatigue decline. The energy of a blaze effect may considerably exceed the energy of the exciting cause. An eyeball will show blaze currents during five days after excision, they diminish under prolonged illumination, and increase under prolonged darkness. The influence of increased temperature and pressure is studied, and under the latter four types of response are recorded.

If single electrical currents are passed through a normal eyeball and a galvanometer in a homodrome and in a heterodrome direction, *i.e.*, with and against the direction of normal discharge, the homodrome (positive) deflection is greater than the heterodrome (negative) deflection.

EDINBURGH.

Royal Society, December 3, 1900.—The Rev. Prof. Duns in the chair.—Dr. R. J. A. Berry read a paper on the true cæcal apex, or the vermiform appendix—its minute and comparative anatomy. The object of the microscopical investigation was to see what, if any, analogies exist between the true apex of the cæcum in the lower animals and its equivalent, the vermiform appendage, in man. Three types were selected, the rabbit, the cat and the pigeon ; and in these there is a marked accumulation of lymphoid tissue at the true cæcal apex, the accumulation reaching its maximum development within a week after birth. These developments were illustrated by numerous lantern slides ; and from them, combined with a comparison of the corresponding arrangements in other animals, it was concluded that lymphoid tissue is the characteristic feature of the cæcal apex, the vermiform appendix in man being represented in the vertebrate kingdom by a mass of lymphoid tissue, situated most frequently at the cæcal apex ; that, as the vertebral scale is ascended, this lymphoid tissue tends to be collected into a specially differentiated portion of the intestinal canal—the vermiform appendix ; and that this appendix in man is not, therefore, a vestigial structure, but is a specialised part of the alimentary canal. Dr. Thomas Muir communicated two papers, (1) Some identities connected with alternates and with elliptic functions ; (2) A peculiar set of linear equations, the latter being an interesting case of bi-rational transformation.

Dec. 17.—Lord Kelvin, President, in the chair.—The chairman made a communication on the transmission of force, the main conclusions being that the æther itself could not be subject to gravitation, the supposition involving instability, and that although electric and magnetic force could be explained mechanically in terms of points which acted as sources and sinks of æther flow, no explanation had hitherto been given of gravitational force. We seemed to be compelled to fall back upon the simple assumption that gravitational action was an inseparable attribute of the atoms of matter, that it was a fundamental fact behind which it was impossible to get. Mr. C. Tweedie, M.A., in a note on Dr. Muir's paper on a peculiar set of linear equations, read at last meeting, gave a simpler demonstration of a general theorem suggested in that paper. Prof. J. T. Morrison (Stellenbosch) communicated a paper (date Nov. 6) on a suggested solar oscillation, with some of its possible astronomical and meteorological consequences ; together with a generalisation as to the constitution of matter and the cause of gravitation. The sun was supposed to be subject to a pulsation of twenty-two years' period with reference to an axis nearly coincident with the axis of rotation ; and on this assumption, for which cosmical causes might be plausibly suggested, the sun-spots occurring in the regions of greatest surface displacement received a ready explanation. Variations of temperature accompanying the expansion and contraction of the sun would produce a corresponding periodicity in the vertical projection of

material from the sun, giving rise to the streamers. These, acting on the lighter materials of approaching and receding comets, would tend to form the tails pointing in the well-known manner. Electrons would be projected in great quantity along with the streamers, and would, when they reached the earth, have obvious effects upon terrestrial magnetism. These effects would occur about a year after the outburst on the sun which projected the electrons producing the effects. The second part of the paper was very speculative, and aimed at showing that gravitation and electric force were fundamentally the same. A fuller presentation of this theory was promised in a future paper.

PARIS.

Academy of Sciences, Dec. 31, 1900.—M. Maurice Lévy in the chair.—Revision of the arc of meridian of Quito, by General Bassot. The necessary funds having been voted by the French Government, the plan of operations proposed is sketched out, and the names of the surveying party given. It is proposed to measure about six degrees of arc, and the operations, which will be commenced about June 1901, will probably take four years. A committee of the Academy, consisting of MM. Faye, H. Poincaré, Hatt, Bassot and Lœwy, was appointed to control the operations of the mission.—Rectification of an analytical datum relating to the amount of hydrogen disengaged from granites by acids, by M. Armand Gautier. In a note previously published upon this subject, the amount of hydrogen given was too large, as it has been found that the powder was contaminated with some iron introduced accidentally during the process of powdering.—On the differentiation of the vascular tissues of the leaf and stem, by M. Gaston Bonnier. An examination of the origin of the vascular meristem in the leaf, and a comparison of its differentiation with that of the analogous tissues occurring in the stem. The paper is accompanied by eight illustrations.—M. Dedekind was elected a correspondent for the section of geometry, and Prof. Strasburger a correspondant for the section of botany, in the place of Sir Joseph Hooker, elected Foreign Associate.—Remarks by General Sebert on the report of the French Association for the Advancement of Science.—On the longitude of the moon, by M. H. Andoyer. In the development of the co-ordinates of the moon in trigonometrical series by Delaunay, the coefficients are inexact. The correct coefficients, recalculated by two independent methods, are now given.—On a new calculating circle, by M. Pierre Weiss. The circular slide rule described has a diameter of 16 cm., and possesses an accuracy of 1 in 2000. It is claimed that this instrument is simpler in working than the ordinary straight form of slide rule.—On a relation between the coefficient of expansion and the melting-point of metals, by M. Lémeray. It is shown that if the coefficients of expansion of the metals are plotted against their absolute melting-points, the points lie roughly on a rectangular hyperbola.—The constant of universal gravitation. On a cause of asymmetry in the use of the Cavendish balance, by M. Marcel Brillouin.—The direct application of a telephonic receiver to wireless telegraphy, by MM. Popoff and Ducretet. A telephonic receiver for the Hertzian waves is described and figured. By its use the relays and the striker or automatic decoherer can be dispensed with, and the sensitiveness of the instrument is greatly increased, messages sent by a small Ruhmkorff coil (4 mm. spark) being easily made out at a distance of 500 metres, the ordinary arrangement with relays giving no response under the same conditions.—On the diurnal variation of atmospheric electricity, by M. A. B. Chauveau.—On the place of indium in the classification of the elements, by MM. C. Chabrié and E. Rengade. The assumption of an atomic weight of 113 for indium, corresponding to the oxide In_2O_3, is confirmed by the preparation of well characterised alums with cæsium and rubidium. The acetonylacetonate of indium was also prepared, in the hope of determining its molecular weight by means of its vapour density, but although a well-defined crystalline acetonylacetonate was obtained, it was not volatile.—Study of uranium nitrate, by M. Œchsner de Coninck. Solubility determinations in different organic liquids.—The crystalline form of the luteocobaltic chlorsulphate and chlorseleniate, by M. T. Klobb.—On the osmosis of liquids through a membrane of pig's bladder, by M. G. Flusin. It has been shown in a previous communication that the velocity of osmosis of liquids through a membrane of vulcanised rubber varies in the same manner as the absorption capacity of the membrane for the liquids. The same relation has now been found to hold for a membrane of pig's bladder.—The anti-coagulating action of intravenal injections of the milk of one animal species upon the blood of animals of the same species, by M. L. Camus.—The cytological formula of the normal serosities of the pleura and peritoneum of the ox, by MM. J. Sabrazes and L. Muratet.—On the muscular serum, by M. Charles Richet. Muscle serum, although taken normally into the stomach as a food substance, produces strong toxic effects when injected under the skin. This effect is not produced after the serum has been coagulated by heat.—Indications of organic substances in certain mineral waters in the precipitate obtained with barium hydrate, by M. F. Garrigou.—On the common origin of the tissues of the leaf and stem in Phanerogams, by M. Léon Flot.—The presence of methyl alcohol in the fermented juices of several fruits, by M. Jules Wolff. The juices of the following fruits were examined:—black currants, prunes, mirabelle plums, cherries, pears, white and black grapes. After fermentation, the alcohol obtained was found to contain small quantities of methyl alcohol, varying from 2 per cent. for the spirit from black currants to 0·15 per cent. in that from grapes.

NEW SOUTH WALES.

Royal Society, November 7, 1900.—The President, Prof. Liversidge, F.R.S., in the chair.—Current Papers, No. 5, by H. C. Russell, C.M.G., F.R.S. This paper includes the records of 108 current papers collected during the past thirteen months. The total number of papers recorded in the whole series is now 602; these have been published in the Society's *Proceedings*. At this stage it is worth while to see what important results have been attained. Beginning, then, in the Indian Ocean, it is found that north of the Equator current papers drift to the eastward, but the number of papers found is too small to determine the rate of drift. From the Equator to latitude 10° south, current papers drift easterly on to equatorial Africa; five papers in this area made an average drift of 13·3 miles per day. Taking the next section, that is, from 10° south to 23° south, the average daily rate derived from eleven papers is 16·5 miles. From 23° south to 33° south, no papers have been found drifting westerly or easterly, except a few papers put afloat close to Australia, and they, as usual, went ashore. In the next area, *i.e.* between 33° south and 43° south, in the Indian Ocean, the current papers drift easterly, or, more accurately, east-north-east; twenty-one long distance papers in this area give an average daily drift of 7·6 miles. In the next section, *i.e.* 43° south to 50° south, twenty current papers show a daily easterly drift of 9·4 miles. Tabulating the dates at which current papers are found, it appears that the smallest number of current papers came ashore at the times of the *Equinoxes* (March and September), and the greatest number received in one month of each year is:—May 1897, ten papers; October 1898, twelve papers; August 1899, fourteen papers; and February 1900, fourteen papers.—The Sun's Motion in Space, Part i., History and Bibliography, by G. H. Knibbs. Apart from its intrinsic interest, the determination of the direction and quantity of the sun's motion in space is of importance, as the condition of further progress in developing a satisfactory system of defining the places of stars. The establishment of such fixed planes of reference as will be unaffected by the relative or absolute motions of the sun and stars, even for great periods of time, is clearly a desideratum, if not essential in any thorough scheme of analysis of such movements. The preliminary paper (Part i.) gives an account of the history and bibliography of the development of the idea of a motion of translation of the sun through space, and also of the determinations of the direction and amount of this motion, indicating briefly, at the same time, the general principles underlying those determinations. The conception of an indefinitely extended stellar universe, in which the sun and its planetary system is but a single and perhaps insignificant member, is one that the world owes to Giordano Bruno, in 1584. The part played by Bruno, Schyrleus, Fontenelle, Halley, Bradley, Wright, Kant, Mayer, Lambert, Michell and Lalande in establishing and extending the conception is indicated. The first deduction of the direction of the solar motion was made by Pierre Prévost in 1781 from twenty-six stars, the latest by Kobold from 2262 stars.—On a Eucalyptus oil containing sixty per cent. of geranyl acetate, by Henry G. Smith. In this paper the author shows that the oil of *Eucalyptus macarthuri*, known locally as Paddy's River Box, is very rich in geraniol, it containing 60 per cent. of geranyl acetate, and 10·64 per cent. of free alcohol, calculated as geraniol.

Linnean Society, Nov. 28, 1900.—Mr. Henry Deane, Vice-President, in the chair.—Notes on the botany of the interior of New

South Wales, Part ii., by R. H. Cambage. The vegetation met with in journeying from Cobar to the Bogan River above Nyngan, a distance of about 120 miles, is described, with special reference to the Eucalypts and their relation to geological formations.—On the Australian fairy-ring puff-ball (*Lycoperdon furfuraceum*, Schaeff.), by D. McAlpine. Bare circular patches met with in certain bowling-greens in the suburbs of Melbourne were found to be caused by a puff-ball which produced the appearance known as "fairy-rings." The puff-ball causing these rings is *Lycoperdon furfuraceum*, Schaeff., a fungus which has not hitherto been recorded from Australia, nor has it been found associated with "fairy-rings" in the Old World.—Studies on Australian Mollusca, Part iii., by C. Hedley.—Several molluscan genera new to Australia—*Blauneria*, *Stenothyra*, *Leuconopsis* and *Iravadia*—are here announced, all but the first-named of these being represented by new species. A new genus is erected for the reception of *Neritula lucida*, Ad. and Angas. New marine species from New South Wales, a new snail from Queensland, and records of new habitats conclude the article.—Note on an echidna with eight cervical vertebræ, by Dr. R. Broom. In a series of skeletons of echidna tabulated by McKay (*Proc.* Linn. Soc. N.S.W. (2), ix. 1894, p. 265) considerable variation in number is shown in all the groups of vertebræ with the exception of the cervicals. In the case now described, the eighth vertebra, which ought to be the first dorsal, is provided with a pair of quite rudimentary ribs, and is thus really a cervical vertebra.—On the ossification of the vertebræ in the wombat and other marsupials, by Dr. R. Broom. An examination of the mode of ossification of the vertebræ in a number of types of marsupials has revealed some interesting points. The odontoid process of the axis is ossified from a single median centre instead of from a pair as in man and probably most of the higher mammals. The 3rd-7th cervical vertebræ are ossified from three centres. The dorsal vertebræ are developed similarly to those in the higher mammals; and in the majority of marsupials the same may be said of the lumbar vertebræ. In the wombat (*Phascolomys mitchelli*), however, a remarkably interesting exceptional condition is presented. The first three lumbar vertebræ are developed from three centres as in man, but the fourth differs in having well-marked autogenous transverse processes. —Contribution to the bacterial flora of the Sydney water supply, Part ii., by R. Greig Smith. A *résumé* is given of the various methods that have been recommended for the selective examination of water and especially for the separation of *Bact. typhi* and *Bact. coli commune*.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 10.

MATHEMATICAL SOCIETY, at 5.30.—On the Singularities of Quartic Curves: A. B. Basset, F.R.S.—On Streaming Motions past Cylindrical Boundaries: Prof. Love, F.R.S.—On some Cases of the Solution of $x^{p^n} \equiv 1$, mod. p: Prof. F. S. Carey.—On the Zeroes of Bessel's Functions: E. W. Barnes.—A Proof of the Third Fundamental Theorem in Lie's Theory of Continuous Groups: J. E. Campbell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Capacity in Alternate Current Working: W. M. Mordey.—*And, if time permit*: The Use of Aluminium as an Electrical Conductor, with New Observations upon the Durability of Aluminium and other Metals under Atmospheric Exposure: John B. C. Kershaw.

FRIDAY, JANUARY 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.—On Mechanically Correcting the Rotation of the Field of a Siderostat: H. H. Turner.—On a Method of Reducing Occultations of Stars by the Moon, together with the Reduction of Occultations observed on Three Occasions at the Liverpool Observatory: H. C. Plummer.—On the Accuracy of Eye Observations of Meteors, and the Determination of their Radiant Point: Bryan Cookson.—Leonids observed at Cambridge Observatory, November 13-15, 1900: J. C. W. Herschel.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Geodesy: Wilfrid Airy.

MALACOLOGICAL SOCIETY, at 8.—On the Anatomy of *Helix ampulla* of Benson and its Generic position in the Ariophantinæ: Lieut.-Colonel H. H. Godwin-Austen.—A Third Report on Japanese Helicoid Landshells: G. K. Gude.—On the Anatomy of *Buliminus djurdjurengis*, Ancey, from the Djurdjura Mountains, Kabylia: R. Murdoch.

MONDAY, JANUARY 14.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in the Canadian Rocky Mountains: Prof. Norman Collie, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Structure of Metals: Prof. J. A. Ewing, F.R.S.

TUESDAY, JANUARY 15.

ROYAL INSTITUTION, at 3.—Practical Mechanics: Prof. J. A. Ewing, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—Third Contribution to the Ichthyology of Lake Tanganyika: G. A. Boulenger, F.R.S.—On some New and Interesting Exotic Spiders collected by Messrs. G. A. K. Marshall and R. Shelford: Rev. O. P. Cambridge, F.R.S.—Contributions to the Anatomy of Picarian Birds. No. IV. On the Skeleton of the Ground-Hornbills, *Bucorvus abyssinicus* and *B. caffer*: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: Glasgow Bridge: B. H. Blyth.—Railway Bridge over the Fitzroy River, at Rockhampton, Queensland: W. J. Doak.—The Niagara Falls and Clifton Steel Arch Bridge: L. L. Buck.—*Paper to be read, time permitting*: The Present Condition and Prospects of the Panama Canal Works: J. T. Ford.

ROYAL STATISTICAL SOCIETY, at 5.

WEDNESDAY, JANUARY 16.

SOCIETY OF ARTS, at 8.—Photography of Natural Colours by the McDonough-Joly Process: H. Snowden Ward.

ROYAL METEOROLOGICAL SOCIETY, at 7.45.—Annual General Meeting.—Address on the Climate of Norway and its Factors, by the President, Dr. C. Theodore Williams.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Meeting.—Address by the President.

ENTOMOLGICAL SOCIETY, at 8.—Annual Meeting.

THURSDAY, JANUARY 17.

ROYAL SOCIETY, at 4.30.

ROYAL INSTITUTION, at 3.—The Origin of Vertebrate Animals: Dr. Arthur Willey.

SOCIETY OF ARTS (Indian Section), at 4.30.—Metalliferous Mining in India: Dr. John W. Evans.

LINNEAN SOCIETY, at 8.—On the Affinities of *Aeluropus melanoleucus*, Prof. E. Ray Lankester, F.R.S., with a Description of the Skull and some of the Limb-bones: R. Lydekker, F.R.S.—On the Natural History and Artificial Cultivation of the Pearl Oyster: Dr. H. Lyster Jameson.

CHEMICAL SOCIETY, at 8.—The Preparation of Esters from other Esters of the same Acid: T. S. Patterson and Cyril Dickinson.—Tecomin: a Colouring Matter derived from *Bignonia tecoma*: T. H. Lee.—A New Method for the Measurement of Ionic Velocities in Aqueous Solution: B. D. Steele.—Metal-Ammonia Compounds in Aqueous Solution. II. The Absorptive Powers ef Dilute Solutions of Salts of the Alkali Metals: H. M. Dawson and J. McCrae.

FRIDAY, JANUARY 18.

ROYAL INSTITUTION, at 9.—Gases at the Beginning and End of the Century: Prof. J. Dewar, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.—*Possibe* discussion upon Mr. H. A. Humphrey's paper on Power Gas and Large Gas-Engines for Central Stations.

CONTENTS.

THURSDAY, JANUARY 17, 1901.

MODERN THERMODYNAMICS.

An Outline of the Theory of Thermodynamics. By Edgar Buckingham, Ph.D. (Leipzig). Pp. xi + 205. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.)

THE study of thermodynamics is customarily approached, in treatises and text-books, from a point of view to a great extent the reverse of that which is adopted in opening up the subject of dynamics. In dynamics, the usual treatment is essentially theoretical, as opposed to experimental. Newton's laws of motion are regarded as axiomatical; the second and third laws are employed to afford quantitative definitions of force and mass respectively, the parallelogram of forces is practically assumed, and all which follows is mere mathematics. It is only quite recently that the possibility of teaching dynamics from a more experimental standpoint has been seriously considered.

In thermodynamics it is usual to go to the other extreme. Temperature is defined in the first place by a common thermometer, calorimetry is treated largely in its experimental aspect, and the first law of thermodynamics thus becomes more closely associated in the reader's mind with Joule's experiments on the "mechanical equivalent of heat" than with its interpretation as affording a definition of "quantity of heat." The ordinary treatment of the mechanical equivalent of heat would, in fact, have an analogue in dynamics if we were to start with the pound weight as unit of force, and to define the constant g as the "kinetical equivalent of force."

Of recent years a great impetus has been given to the study of higher thermodynamics by the development of physical chemistry based on the theories first enunciated by Willard Gibbs. The experimental study of what at first was a purely mathematical investigation plays a part in the history of science closely analogous with the experimental verifications of Maxwell's theory by Hertz's discovery of electromagnetic waves. This new development has, to quote Mr. Buckingham's own words, caused "a considerable gap between the text-books available and the modern memoirs." Mr. Baynes's treatise, so long the favourite English introduction to thermodynamics, does not deal with thermodynamic potentials, yet it is with the study of these functions that modern thermodynamics is primarily occupied. Several subsequent attempts have been made to produce text-books on thermodynamics, but their writers have generally introduced long digressions on extraneous matter while omitting many of the most important features of the theory.

What we have been wanting was, in the first place, an application to thermodynamics of the same deductive methods that have been used in building up other connected theories, such as rational dynamics and hydrodynamics, and, in the second place, an introduction to the study of the thermodynamic potential, the conditions of thermodynamic equilibrium and stability for a generalised system the state of which is defined by any number of variables, and not merely by two of the pressure, volume temperature triad, and, lastly, an exposition of the phase rule. In compiling this book Mr. Buckingham is practically alone in the field, and the result of his efforts will greatly remove the difficulties which most students experience in acquiring a knowledge of thermodynamics.

In Chapter i. (Thermometry) the author defines equality of temperature, and enunciates the axiom of equal temperatures, according to which bodies which are of equal temperature with a third body are themselves of equal temperature. Absolute temperature cannot, of course, be defined until the second law; but in introducing the so-called "absolute gas scale," the author is careful to guard against misleading assumptions. In Chapter ii. (Calorimetry) the various heat-units are discussed, and the advantage of the dynamical unit explained. The next chapter practically defines thermodynamic systems and thermodynamic equilibrium; while in Chapter iv. we have the first law enunciated in the form of the statement that for a cyclic process the integral of $dW+dQ$ is zero. Chapters v. and vi. deal with the problem of thermochemistry and the thermal properties o fluids, so far as they can be deduced from the first law alone. A recapitulation of the first six chapters makes up the seventh.

Chapter viii. deals with the second law of thermodynamics. The author, having previously defined absolute temperature on the ideal gas scale, here expresses the efficiency of an ideal gas engine in terms of the temperatures, so defined, of the source and refrigerator. In his proof, Boyle's and Joule's laws are assumed. We do not altogether like this order of treatment. We should prefer to see the second law treated somewhat earlier and used to furnish a definition of absolute temperature the properties of gases, as affording a measure of temperature, being subsequently deduced from Boyle's and Joule's law combined with the first and second laws. This method would altogether obviate the necessity of introducing the "gas scale of temperature." Still, the author is so careful in pointing out what is assumed and what is proved in his work that his order of treatment cannot raise any serious objections.

General Equations (Chapter ix.) introduce the thermodynamic potentials. The next chapter deals with the theory of the plug experiment for determination of absolute temperature, Lord Kelvin's equation, application of the laws of thermodynamics to the E.M.F. of a galvanic cell, change of state, and change of osmotic pressure with the temperature.

In the next chapter we have a summary of the hypotheses and conditions involved in the criteria of thermodynamic equilibrium, followed, in Chapter xii., by a concise account of applications of these conditions involving the use of the thermodynamic potentials, in which Duhem's "total thermodynamic potential" and Helmholtz's "free energy" find their explanations. The book concludes with an application of the free energy principle to the galvanic cell, and a discussion on the triple point, which latter leads naturally up to the more general theorem embodied in Gibbs's phase rule. The discussion of this theorem is somewhat condensed, the author referring to the original papers for a more detailed investigation; but for the readers of a book such as the present the

brevity of the treatment is probably an advantage. A short bibliography forms a useful appendix.

As implied in the title, the author's object has been to give a general outline of the fundamental theory, and not to enter into detailed discussions of applications. The book thus deals exclusively with the theoretical, as distinct from the experimental, aspect of thermodynamics. It may with advantage be studied in conjunction with any treatise in which the theory of heat is studied from the experimental side, and a clearer understanding of the subject will be obtained than would have been the case had Mr. Buckingham written a larger volume, containing a mixture of theoretical and experimental investigations. In a subject like thermodynamics, the fundamental axioms cannot, as a rule, be verified directly by experiment, and we are compelled to use what Dr. Stoney calls the *a posteriori* method. The evidence in favour of the axioms is mainly derived from comparing the conclusions to which they lead with the results of observation. It is important in the theoretical investigation that no assumption should be made which is not expressly stated, and Mr. Buckingham appears at least to have exercised considerably more vigilance in this respect than any previous writer. We should like to see an outline of the theory of electromagnetism treated on parallel lines. Mr. Buckingham's treatise will be an indispensable addition to the library of every physicist or physical chemist, as well as of every applied mathematician who studies thermodynamics, and the author has done much to place the introductory treatment of the subject on a sound and rational basis.

AN AUTHORITATIVE TEXT-BOOK OF PHYSIOLOGY.

Text-book of Physiology. Edited by E. A. Schäfer. Vol. ii. Pp. xxiv. + 1365. (Edinburgh and London: Young J. Pentland, 1900.)

THIS volume consists of 1258 pages of text, 97 pages of indices (subjects and authors), and is illustrated by 449 woodcuts. There is no preface. The following epitome shows the subjects dealt with, their respective authors, and, in brackets, the length of each article:—"Mechanism of the Circulation of the Blood," by L. Hill (1-168); "Contraction of Cardiac Muscle," by W. H. Gaskell (169-227); "Animal Mechanics" (228-273), "Sense of Taste" (1237-1245), "Smell" (1246-1258), J. B. Haycraft; "Muscular and Nervous Mechanism" of "Respiratory Movements" (274-312), of the "Digestive" (313-337), "Urinary" (338-346) and "Generative Tracts" (347-351), E. H. Starling; "Properties of Striped Muscle" (352-450), J. Burdon Sanderson; "Nerve" (451-560), "Electrical Organs" (561-591), Francis Gotch; "Nerve Cell" (592-615), "Cerebral Cortex" (697-782), E. A. Schäfer; "Sympathetic Nervous System" (616-696), J. N. Langley; "Spinal Cord" (783-883) and "Parts of Brain below Cerebral Cortex" (884-919), "Cutaneous Sensations" (920-1001) and "Muscular Sense" (1002-1025), C. S. Sherrington; "Vision" (1026-1148), W. H. R. Rivers; "Ear" (1149-1205), "Vocal Sounds" (1206-1236), J. G. McKendrick and Albert A. Gray.

Those familiar with the modern development and advances recently made by British physiologists will see at once that the selection of authors is a guarantee of the excellence and accuracy of the subject-matter of the several essays; for they may be regarded as such, each essay containing the results of the observations to which the author has directed his particular attention.

It appears to us that Hill's article on the circulation is an excellent *résumé* of the subject, and the author acknowledges that he is greatly indebted to the perhaps not sufficiently well-known "Lehrbuch der Physiologie des Kreislaufes," by R. Tigerstedt (1893), who has recently become professor of physiology in Helsingfors. There has been incorporated all those recently discovered facts bearing on the action and distribution of vaso-motor nerves, and influence of gravity on the circulations, with which readers of the *Journal of Physiology* are familiar.

Gaskell's paper is a philosophic discussion of the many observations that have been made on the action of cardiac muscle. It is done with a master hand, and by one who has materially advanced our knowledge of the subject. Gaskell explains the beat of the heart, the sequence of its contractions, &c., without bringing in ganglion cells at all; and he sees no more reason to assign special functions to these cells than to any other of the peripheral efferent nerve cells; and we think that he makes good his case.

Starling's articles give a clear and precise account of the subjects with which they deal, but we confess that we think a short chapter on the comparative physiology of some of the subjects would have been most valuable. In discussing the influence of the higher parts of the brain on the respiratory centre, we failed to find noted the researches of Marckwald on the effect of plugging the blood-vessels of certain cerebral areas by injecting coloured fluid paraffin wax. These results point to the importance of the posterior quadrigemina and the nuclei of the sensory part of the fifth cranial nerve as important factors in the discharge of rhythmical respiratory impulses (*Zeit. für Biol.*, vol. xxvi.). The earlier observations of Marckwald are given. We are glad to see a full exposition of the work of Kronecker, Meltzer and others on swallowing of liquids.

The mechanical, thermal and chemical properties of striped muscle are exhaustively treated by Burdon Sanderson, as was to be expected from one who has devoted so much time to the study of the time relations of muscle in action, and who, by the introduction of new methods, has added materially to the apparatus by which time-problems in other tissues may be solved. The same may be said of the admirable article on "Nerve" by Gotch, while his paper on "Electrical Organs" groups up succinctly the chief facts and theories regarding these wonderful organs. As to the nature and activity of these organs, Gotch is led to the view that, as the only excitable structures there present are the nerves and their fine terminations, the organ change is closely related to the production of molecular disturbances in its contained nerves. In any case, he regards the essential primary disturbance constituting the organ shock as nervous.

In the editor's article on the "Nerve Cell" we have, as a basis, a *résumé* of the more recent advances in the minute structure of these organs. The modern "theory of isolated units," often spoken of as the "neurone theory," he regards as by no means conclusively proved. In any

case the "neuron" terminology, as introduced by Waldeyer, has taken deep root in neurology.

Langley's article on the sympathetic and allied nervous systems is a masterly summary of a subject which, by his researches, he has made peculiarly his own, and groups up in an easily accessible form the many scattered observations on this subject.

The important topic of the "Cerebral Cortex" is fully dealt with by the editor. In mentioning the old experiment of Kircher, known as the "experimentum mirabile," it is set down to "Kirscher" (p. 712). Several of the illustrations are acknowledged from the well-known work of François-Franck and Pitres. The author deprecates the use of the term "sensori-motor," as applied to denote the so-called "motor" or excitable centres in the Rolandic area, although he does not object to the term "psycho-motor" applied to them. A difficult subject is dealt with in a terse but comprehensive manner.

Sherrington's article on the spinal cord displays a mastery of his subject which at once elicits one's admiration. Necessarily, in dealing with the mass of detail many new terms have to be coined for the numerous phenomena which have been discovered in recent years. There is a due admixture of the historical with the results of recent research. What the Germans call Bell's law appears here as "Bell-Magendie law." The word "Bahnung," introduced by Exner into nerve physiology, is, we think, better rendered by "facilitation," adopted by Sherrington, than any of the other proposed equivalents we have seen.

It is evident that a large amount of industrious application has been expended by Sherrington on his articles on "Cutaneous Sensations" and on "Muscular Sense." In the former we find the recent work of Goldscheider, v. Frey and Kiesow treated with ample detail; but perhaps the article on the "muscular sense," grouping up as it does the numerous stray observations, will attract much attention. The value of Sherrington's own work on the "Muscle-spindles," which he showed degenerated after section of the posterior nerve roots outside the spinal ganglion, laid the basis of a more definite physiology regarding the important part played by certain afferent impulses from striped muscle in regulating the activities of the parts from which they proceed. Indeed, the chapter on "the peripheral apparatus of the muscular sense," though short, is an excellent *résumé* of the present knowledge of this important subject, and to which clinicians will find it profitable to devote their attention.

The essay on "Vision" is somewhat unequal, but how can it be otherwise on a subject so vast and which is treated with such wealth of detail in Hermann's "Handbuch der Physiologie."

Although necessarily there is much comparative physiology scattered throughout its pages, we could have wished to see the main facts of the comparative physiology of at least some of the subjects summarised in separate chapters. The work is one which reflects great credit on British physiologists, and we heartily congratulate the editor on its production—a work which must have entailed great labour and careful supervision. Perhaps when the next edition is called for it may be issued in three volumes, as volume ii. has reached rather bulky dimensions.

THE ROYAL OBSERVATORY, GREENWICH.

The Royal Observatory, Greenwich; its History and Work. By E. W. Maunder. Pp. 320. (London: the Religious Tract Society, 1900.)

THE history of the Royal Observatory extends over two centuries and a quarter, and its work is certainly not lacking in general interest; yet Mr. Maunder seems to be the first person to produce a popular account of them, and he has left little room for improvement to any one who comes after him in the near future. The history occupies the first 124 pages of the book in five chapters, and the description of the place as it is to-day, and the work as it is now going on, occupy the other 192 pages in eight chapters. This is probably a fair arrangement. Those who would have liked a little more of the history can find it in such works as Bailey's "Life of Flamsteed," or Rigaud's "Life of Bradley.' A "Life of Halley," on a scale worthy of him, has long been wanted, and has several times been nearly undertaken, but the project has, for one reason or another, always fallen through.

The predecessors of the present Astronomer Royal number seven: Flamsteed, Halley, Bradley, Bliss, Maskelyne, Pond, Airy. Of these Bliss only filled the position for two years; but the others lived long and worked hard at their posts, Flamsteed, Maskelyne and Airy for nearly half a century each; Halley, Bradley and Pond for nearly a quarter. And though there is so much straightforward routine work in astronomy, especially at a national observatory (and among national observatories, especially at Greenwich), yet the names of the Astronomers Royal are all associated with one or two notable events, often, though not always, special achievements of their own. The name of Flamsteed calls up at once the foundation of the observatory (which was in great measure due to him), and unfortunately also the quarrel with Newton; that of Halley, the publication of the Principia, and the first prediction of the return of a comet; that of Bradley, the discovery of Aberration and Nutation, as well as his fine catalogue of stars; that of Maskelyne, the invention of lunar distances and the chronometer, and the establishment of the *Nautical Almanac.* Airy deserves to be remembered as the man who first suggested how to compensate the compass in iron ships, though, like Flamsteed, he was unfortunate enough to leave another reputation, from his attitude towards the discovery of Neptune. Pond and Bliss are something of exceptions; but the former has recently been eulogised by Mr. Chandler as a phenomenal observer; and even of Bliss we may say that it was a distinct achievement to leave behind him only one authentic portrait, and that scratched by a boon-companion on a pewter-flagon! The seven Astronomers Royal were not only men of ability, who worked hard, but men of clear-cut individuality; and their average length of life was nearer four score years than three score years and ten. We ought to have all their portraits in our National Portrait Gallery, including an electrotype of that curiosity inscribed "This sure is Bliss, if Bliss on earth there be."

Mr. Maunder has given us the main facts of these interesting lives in a thoroughly readable form. He then passes on to the Observatory as it is now, and we must

not forget that its present size and arrangement are due, not only to the seven men mentioned above, but also to nineteen years' work from Mr. Christie, the present Astronomer Royal. In these nineteen years he has contributed to the buildings and equipment about as much as his seven predecessors together. There is a new transit-circle, which can be used on or off the meridian; the 13-inch refractor has been increased and multiplied into a 28-inch visual refractor, a 26-inch photographic refractor, and a 30-inch reflector, besides the 13-inch astrographic equatorial; and a large, commodious building has been erected, which more than doubles the space available for computing, measuring photographs, and all the miscellaneous duties of which the lay-mind has probably never imagined the existence. In this noble extension of our National Observatory, the Astronomer Royal has been generously helped by others, and especially by Sir Henry Thompson, who gave two of the large telescopes, and by Mr. Crisp, the architect of the new buildings, whose name we are sorry not to find in Mr. Maunder's book.

On one day in the year, "Visitation Day," the Observatory is devoted to visitors; and though it is not even then thrown open to the public, those with a definite interest in astronomy can generally obtain a card of admission. They find a great many things to see—those who see them for the first time find the number and variety almost bewildering; there is, in fact, the year's work of fifty busy people to look at, as well as the complicated instruments with which it was done. Things have changed somewhat, in spite of the reluctance of economical Governments, since Flamsteed was installed as Astronomer Royal in 1676 with a salary of 100*l.* a year, a "surly labourer" to help him, and no instruments! To such as are fortunate enough to be admitted on these annual occasions we can recommend the later chapters of the book for perusal both before they go and after they come away; a number of technical matters are described in a thoroughly attractive way.

Sometimes in reading a book a stray sentence or two impress the memory, though they may be only incidental to the main theme. Pond's notion of the kind of man who would make a good assistant in an observatory arrests the attention:—

"I want indefatigable, hard-working, and, above all, obedient drudges (for so I must call them, although they are drudges of a superior order), men who will be contented to pass half their day in using their hands and eyes in the mechanical act of observing, and the remainder of it in the dull process of calculation."

There is undoubtedly a vast amount of drudgery in astronomy, if people choose to so regard it. Other sciences multiply their observations ten or a hundred times; the astronomer deals in thousands and even millions. But men with the spirit of drudges, as Mr. Maunder truly remarks, cannot be trusted to do the work honourably and therefore accurately; and besides this the work is *not* drudgery. Mechanical it may be, but good men and true have found it far from dull. Did Herschel find it dull to pass the whole heavens in review star by star? Does Mr. Denning, of Bristol, find it dull to watch night after night for long hours on the chance of observing a few meteor-tracks, and that after a day's business toil? If it were drudgery they would have stopped, but Herschel went on, and Mr. Denning goes on, and these are only two random instances out of hundreds.

At the same time Pond put his finger on a real difficulty, which is just as pressing to-day, nay, far more pressing since the introduction of photography into astronomy has so enormously increased the work. How are we to get through this work? The army of astronomers is so small; it has not been recruited with sufficient rapidity to keep pace with the extension of our Empire. Pond thought of drudges, as commanders of old employed mercenaries: both found them unsatisfactory. What is the real solution? Conscription will scarcely work here. Will the volunteers solve the difficulty, or may we hope for a big reorganisation scheme?

H. H. T.

THE MANAGEMENT OF ROADS.

Road-making and Maintenance: a Practical Treatise for Engineers, Surveyors and Others. By Thomas Aitken, Ass.M.Inst.C.E. Pp. xvi + 440. With numerous plates and illustrations. (London: Charles Griffin and Co., Ltd., 1900.)

SINCE the introduction of bicycles and motor-cars the question of road maintenance has come very much to the front. It formed one of the subjects discussed in Section G at the late meeting of the British Association, and was considered of sufficient importance to warrant the appointment of a committee to inquire generally into the subject, but more especially as to the effect of the condition of the surface of roads on the tractive force required to move vehicles along them.

The author of the book under notice has given an interesting account of the history of road-making from the time of the ancient inhabitants of Peru, and of the Romans, to the days of road revival in this country, when General Wade was employed by the Government in constructing about 250 miles of roads through the Highlands of Scotland as the most effectual means of putting an end to the Rebellion of 1715.

Then followed the establishment of turnpike trusts, no less than 1100 Acts of Parliament having been passed for this purpose, and a very large amount of capital was raised for opening out new, or improving old, roads. In this work Telford, the father of modern civil engineering, constructed over 900 miles at a cost of nearly half a million of money. So great was the revolution in the condition of the roads that Macadam, another of the great road-makers, was described as being regarded by the public as a sort of magician, and his invention something preternatural. As the result of their work it became possible to run stage coaches between the principal centres of population at the rate of ten miles an hour. The establishment of railways and the termination of the turnpike trusts under provisions contained in the Acts of Parliament led to the decadence of the main roads of the country, the management of the old turnpikes having reverted to the parochial surveyors. A certain amount of improvement took place when the system of grants out of the county rates towards the maintenance of the main lines of communication was introduced, these

grants being subject to the roads being kept in repair to the satisfaction of the county justices. A further improvement took place when these roads were taken over by the County Councils.

The bicycle has, however, been the main agent in recent road improvement. To use these machines with any comfort a road must be in thoroughly good order, level, and free from loose stones and mud. The voice of the bicyclist is heard everywhere calling out when roads are in bad order, and local legislators are driven both by their own experience and that of their constituents to bring about a better condition of the main roads and highways. An institution known as the Roads Improvement Association has been formed, and, besides bringing pressure to bear on the local authorities, has issued a great quantity of literature for the guidance of local surveyors and roadmen as to the management of the roads; upwards of 13,000 pamphlets containing practical information on the management of roads have been distributed by this society.

Fortunately road reformers are able to show, by conclusive evidence, that roads kept in thoroughly good order cost less in annual maintenance than when they are left to get rutty and uneven and covered with mud or loose stones.

Mr. Aitken's book is a good practical treatise on the making and maintenance of roads. It is divided into fifteen chapters, which deal respectively with the history of road-making; traction; the construction of new roads; bridges, culverts and retaining walls; road material; quarrying; stone-breaking and haulage; road-rolling and scarifying; paved roads, including wood, asphalt, brick, and tar macadam; footways, &c.

The book deals principally with main roads and those subject to heavy traffic, which, as a rule, are now under the care of the county surveyors, who are skilled experts, and very little attention has been given to the requirements of the ordinary highways, where improvement is most required. The space devoted to quarrying, which occupies no less than sixty-seven pages, or about one-sixth of the whole book, could well have been spared, as it is rarely in these days that a surveyor has to quarry his own road material, and the space would have been better devoted to showing how ordinary highways may be maintained in good order and kept level and clean, and material placed on them when required without inconvenience to the traffic in situations where steam road-rolling is impracticable.

OUR BOOK SHELF.

Knowledge, Belief and Certitude. By F. Storrs Turner. Pp. viii + 484. (London: Swan Sonnenschein and Co., Ltd., 1900.) Price 7*s.* 6*d.* net.

MR. STORRS TURNER distinguishes knowledge from consciousness as interpretation from datum. He alleges as base of the former three certitudes, as to self, other selves and real things. He finds the sciences to involve the same pre-conditions and to take a permissibly abstract point of view—that of a fictitious independent spectator. But he holds that, therefore, the sciences are not adequate to concrete reality, while the pretension of science in general to present the whole is vain. In psychology the standpoint of the ideal spectator is inadmissible, and philosophy has failed because of the same abstraction. But among concrete ends we find our conviction as to some certain knowledge satisfied. Real knowledge belongs to the teleological sphere.

His conclusion to the failure of the speculative and the success of the purposive reason surprised Mr. Turner with the force of a revelation. The first chapters of his inquiry, which "remain substantially as they were originally written," were committed to paper years ago when "a dense fog" covered his mind. A trace of this is to be found in the attempt to maintain concurrently that the certitude of other selves is an inference of reason (p. 74), that it is plainly one with the certitude of self (p. 89), and that neither is able to come into existence apart from the other (p. 95). Mr. Turner can say within a page that "by real things we mean permanent things" (p. 80), and that "what we have is the certitude that there are a multitude of real things, some of them permanent, most of them changing" (p. 81). It will perhaps be unnecessary to say that his verbal criticism on such writers as Mr. F. H. Bradley depends for its validity on a hit or miss principle. It is a little grotesque to have estimates of Hegelian metaphysics and post-Hegelian logic from the standpoint of "reflective common-sense, aware of its limitations." Mr. Turner thinks that continuity implies indivisibility, and his verdicts on much in philosophy and science rest on similar misunderstandings.

"Knowledge, Belief and Certitude" is, however, by no means a worthless book. There is a certain dialectical ability in much of it, and a tenacity as to main principles which will appeal to the clear-headed reader who can discount the fallacious element. It is, however, as an honest attempt to think the problem of knowledge right through, and to present a record of the process as well as the results of his investigation, that it chiefly commends itself. How and why Mr. Turner came to his estimate of various views and systems, rather than that estimate itself, is the thing worth studying.

H. W. B.

Notions de Minéralogie. Par A. F. Renard et F. Stöber. II[me] Fascicule; Classification et Description des Espèces Minérales. Pp. 191 to 374. (Gand: Ad Hoste, 1900.)

THE first fascicule of this text-book, containing the general principles of mineralogy, has already been noticed. The second fascicule (pp. 191–374) is devoted to the detailed description of mineral species. A large number of species are mentioned and, consequently, the majority are only briefly treated; in its main features the book necessarily resembles other mineralogical text-books.

It seems that, by a wise provision, all candidates in natural science at the University of Gand devote one hour weekly to the study of mineralogy, and it is for these students that the book is primarily intended. From this point of view we think that, as in most text-books, more species are mentioned than is necessary; such rare minerals, for example, as chalcomenite and nitrobarite should scarcely come within the range of the elementary student, but the brief descriptions of the commoner minerals leave nothing to be desired.

There are several useful features in the book which deserve special mention. In the case of most of the minerals of commercial importance, such as mica, apatite, cassiterite, galena and sulphur, a statement is given of the annual world's yield and its approximate value.

Another important feature is a summary of the minerals of Belgium with their localities, with which the volume concludes. Such local information is extremely useful, and this is the first authentic list of Belgian minerals and localities which has been given. The list has evidently been compiled with care; special attention is

directed to those minerals which are peculiar to Belgium.

Many of the figures will disappoint the modern reader on account of the indifferent printing; but among the illustrations he will find several useful diagrams which are not the familiar figures common to all the text-books, for example, the projection which shows the migration of the indicatrix axes with change of composition in the plagioclase felspars.

The authors have succeeded in producing within a small compass a fairly comprehensive yet lucid treatise on the principles of mineralogy and the chief mineral species, which may safely be recommended to the student in England as well as in Belgium.

The Essentials of Practical Bacteriology: an Elementary Laboratory Book for Students and Practitioners. By H. J. Curtis, B.S. and M.D. Lond., F.R.C.S. (London: Longmans, Green and Co., 1900.)

THIS book consists of a series of lessons upon practical bacteriology, mainly for a course of study required for the Diploma of Public Health. Commencing with the preparation of nutrient media, it passes on to the systematic study of, first, certain typical non-pathogenic bacteria, then to the moulds, including ringworm and allied forms, the account of which is much fuller than usual, and, lastly, to the pathogenic organisms. Fermentation and the beer yeasts are referred to, the malaria parasites, the *Amoeba coli*, and the supposed cancer organisms are described, and the methods employed for the examination of air, water, &c., and for testing disinfectants are given. The practical details described seem to be fairly complete and accurate, and the book is copiously illustrated, many of the illustrations of cultures being extremely good. The *Bacillus enteritidis sporogenes* of Klein is not mentioned, though it is a capital organism for class work. The method of freeing cultures for the "Widal" reaction from clumps by filtration is attributed to Symmers, but is mentioned in Hewlett's "Manual of Bacteriology." The paraffin method of embedding described is needlessly complicated. These and a few other omissions and errors will doubtless be corrected should another edition be called for.

What is Heat? and What is Electricity? By F. Hovenden. Pp. xvi + 329. (London: Chapman and Hall, Ltd., 1900.)

MR. HOVENDEN has set himself the modest task of overthrowing, in the space of about 300 pages, all existing physical tenets, and substituting in their place a remarkable theory of his own. In this effort he has not succeeded, except, apparently, to his own complete satisfaction. In the first part of the book the author quotes freely from Maxwell and others, and endeavours to prove that their reasoning is fallacious. His arguments only show that he does not understand what he quotes, and that he has not appreciated the most elementary principles of the subject, such, for example, as the difference between mass and weight. Having, as he considers, sufficiently disposed of the views held by modern men of science, Mr. Hovenden proceeds to the elucidation of his own theory. It is impossible to regard this part of the book seriously, Mr. Hovenden's deductions from experiments being altogether too extravagantly absurd. It is interesting to note that his treatment of the subject is throughout entirely qualitative; we venture to think that in no single instance would Mr. Hovenden's explanations stand the test of quantitative examination. If modern theory is to be disproved, it will not be by such writings as this. The least one can expect of its opponents is that they should properly understand the fundamental conceptions involved, and this Mr. Hovenden cannot be said to have attempted to do.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On a Proof of Traction-Elasticity of Liquids.

I HAVE read with much interest the note of Mr. T. J. Baker, on a surface-tension experiment (NATURE, No. 1600, June 28, 1900). The author describes, with photographic illustrations, a phenomenon at first observed by Savart (1833), and later studied by Hagen, Tyndall, J. Plateau, Boussinesq and myself, but in all these studies, as in Mr. Baker's note, no other force than surface tension is supposed to produce the different phases of the phenomenon. Therefore I resumed the subject two years ago[1] and endeavoured to explain the consecutive phases by proving that in this experiment there arises always some elasticity of traction, not only in both superficial layers, but even in the whole mass of the sheet.

For example, if the velocity of the jet is extremely high, the liquid is suddenly compressed by the shock against the disc; but on account of the perfect elasticity of the liquid, there is no sensible loss of *vis viva*, and the little expansion is performed in a very minute fraction of a second, during which the liquid is quickly projected in all directions parallel with the plane of the disc, and forms a sheet; as long as the intermolecular distances do not increase, the only retarding forces are the surface-tensions of both faces of the sheet; therefore the central part of the latter is even and transparent. But soon, by the stretching-out of the sheet, all molecules separate from each other, extremely little indeed, but enough to produce suddenly strong resistances; then each coming layer strikes against a retarded one, and so are formed circular strips from which many drops constantly part. Besides, as the elasticity cannot be the same in all points of a circular strip, some radial strips are also produced in the sheet, from whose broken edge very many little drops are continually thrown.

On diminishing the rate of outflow, the production of interior elasticity of traction becomes also smaller, and therefore the transparent portion of the sheet increases gradually; but the edge sinks slowly, and soon closes inwards and reaches the vertical piece supporting the disc. The surface-tension of both faces of the sheet is not the only force which drags in the water radially; for by the action of gravity the sheet can be compared with a membrane of india-rubber, that is to say, all portions are distended, not only in the superficial layers, but even in the interior mass.

It is easy to show that the distension of falling particles is all the greater as the velocity is smaller. Therefore the elasticity of traction produced by gravity increases in the proportion that the movement slackens.

We can now understand why the motion of the liquid in the vicinity of the summit of the closed figure becomes more and more difficult, until the figure rises above the plane of the disc, afterwards falls again and reforms a closed figure of smaller breadth.

With a still slower stream of water, the figure begins to oscillate vertically, just because the force of gravity draws it down, while the elastic force of traction pulls it up.

Ghent, January 2. G. VAN DER MENSBRUGGHE.

Mathematics and Biology.

IN the interesting address of Prof. Howes published in NATURE of December 10 occur the following words:—

"On this basis there are now being pushed forward attempts to apply statistical, experimental and mathematical tests to the study of vital phenomena. All honour to those who are making them, for it is certain there are phases of life capable of mathematical treatment, but the mystery of life can never be thus solved; and, concerning the objection to the observational method, with confirmation and generalisation, and rejection of the non-confirmable, our non-mathematical procedure is scientific. Huxley has long ago said of mathematics that what you get out of the machine depends entirely upon what you put into it."

[1] "*Sur les nombreux effets de l'élasticité des liquides*," 3me Communication (*Bull. de l'Acad. Roy. de Belgique*, 3me série, vol. xxxvi., p. 281, 1898.)

Now I think there are several points in the above sentences liable to misconstruction. Mathematics is purely a *form* of reasoning, and, as in the case of all forms of logic, it is merely an instrument, and the product depends upon the material dealt with. This may be the result of observation or of experiment, either of which may or may not be statistical in character. Prof. Howes, in contrasting "statistical, experimental and mathematical tests" with the "observational method," seems to be looking upon mathematical reasoning as something which has more relation to experiment than to observation. I fail to see why as an instrument it is less applicable to the gigantic overthrust of the geologist than to the test-piece in the laboratory, less applicable to an observation on the mottling of birds' eggs than to an experiment on the breeding of mice. It is perfectly true, as Huxley said, that what you get out of the machine depends entirely on what you put into it. Such a platitude in its right context may be a useful reminder. But *without your machine you may be able to get nothing at all out of your material;* and I venture to think that this is the case, not with a few, but with many branches of biological inquiry.

The reason thereof is easy to find. In vital phenomena we are never able to repeatedly observe or to experiment, as we can very closely do in physics, under exactly the same conditions with the same quantities of the same substances. The reader will probably interject, "No, and this is the very reason why mathematics can be applied to the one and not to the other!" On the contrary, because in biological investigation an exact A cannot be associated with an exact B, and an exact C observed (as we can do in physics), biology requires a much more refined logic, much more subtle mathematics than the simplest branches, at any rate, of physical inquiry do. There is nothing more full of pitfalls than "ordinary reasoning" applied to the problems of association. The biologist observes that *some* A is associated with B, and that *some* C is associated with B. But if he wishes to discover whether the relation between A and C is causal, he will need all the refinements of symbolic logic, a mathematical analysis, which is analogous to the geometry of hyperspace, before he can come to a definite logical conclusion on the possible relationship of A and C. He may observe as much as he will, but he will not find out whether the association is confirmable or non-confirmable without this higher logic. It is the all-pervading law of vital phenomena that no two individuals are identical among living forms, that variation exists in every organ and every character, which, so far from disqualifying biological phenomena for mathematical treatment, enforces a need for the most generalised forms of mathematical reasoning. Prof. Howes tells us that the mystery of life can never be solved by mathematical treatment. If he had said that the mystery of life cannot be solved by any treatment whatever, I should have heartily concurred with him. But if he means that observation, rather than observation plus the higher logic, is likely to discover the most comprehensive formula under which the phenomena of life can be described, then I am quite sure he is in error. Observation, for example, has collected a mass of most valuable facts during the past thirty years, but can any one by merely verbal generalising upon these facts venture to assert that evolution by natural selection is more than a probable hypothesis? The very nature of such ideas as variation, whether continuous or discontinuous, as inheritance, whether exclusive or blended, as selection, whether natural or sexual, leads us to the idea of number, of statistics, of frequency, of association, and enforces upon us an appeal to mathematical logic. If we are to feel that evolution by natural selection is as sure a formula as that of gravitation, it will be because mathematics steps in and reasons on the data provided by the Tycho Brahés and Keplers of biological observation.

Prof. Howes must not for a moment suppose I claim biology for the mathematician. I do not even want the mathematician to have a biological training, conscious as I am personally of the disadvantages of its absence. The mathematician who turns physicist is rarely so valuable a discoverer as the born and trained physicist who knows mathematics so far as he needs them. I believe the day must come when the biologist will—without being a mathematician—not hesitate to use mathematical analysis when he requires it. The increasing amount of work being turned out, both in America and Germany, by the younger biologists with a mathematical training, is a sign of the times. In England, I suppose (where, as usual, an Englishman, Mr. Francis Galton, first indicated the great possibilities of a new method), we shall be left behind, and let other nations gather the fruits of our sowing. Prof. Howes, indeed, leaves a field for mathematical investigation; but it was only a few weeks ago, at a discussion at the Royal Society, that another distinguished biologist asserted that in living forms there was no such thing as number!

Et Verbum interrogabat Vitam: Quod tibi nomen est? Et dicit ei: Legio, id est Numeri, mihi nomen est, quia multi sumus. Et deprecabatur eum multum, ne se expelleret extra regionem.

I doubt whether the demon can now be exorcised conjure *Verbum* ever so cunningly.

KARL PEARSON.

Education in Science.

SOME discussion has recently arisen as to the methods of teaching mathematics. Euclid has been condemned on the score of its advancement and its antiquity. An infusion of more modern geometry has been recommended, with corresponding arithmetic and algebra. In science, at the same time, there has been a tendency to recognise the historic method. Prof. Perry considers it unnecessary for pupils to traverse the course of their ancestors. But let us ask *why* this course has been recommended. On account of the successive growth of faculties in a historical sequence. Is this a fact or not? It is an undoubtable fact, and it is not sufficiently realised by any teachers. Prof. Perry has two saving principles, first to teach by practice, and second to satisfy the pupils' instincts. These being the same reasons which are used by advocates of historical methods secure a certain amount of agreement. We ought to arrive at the same result whether we study the natural methods of pupils, or the methods of primitive peoples. But Mr. Herbert Spencer has well pointed out somewhere that we ought not to go to the Greeks for examples of primitive peoples. They were highly and very specially developed. Hence arises a very great danger in the historic method.

With regard to practical and rational methods, it must have often been noticed by teachers that a great number of pupils have an inherent objection to carrying out rules without some kind of reason for them. It is also to be observed that a very vague, or even a verbal reason, will be more satisfactory than a real one. This is surely in accord with the studies of the history of science. Although it is somewhat misleading to reason from the experience of men of genius, it may be worth while to call to mind the intense satisfaction of Darwin with Euclid's concatenation, and the disgust of Huxley at the irrational rule and rote method of mathematics under which schoolboys grow up. It is the exceptional boy who delights in carrying out enigmatic rules, although all have a temporary taste for that work as sauce to the rest. It is treacherous to reason from one lesson of this kind to a regular course of it.

It is customary to speak of the activity, observation, ingenuity of children. But it is not found, either in the history of children or of primitive peoples, that they are capable of continued mental application, observation or contrivance. We might just as well speak of the great reasoning powers of children on account of their perpetual "why." It is also improper to underestimate the value of this tendency. By it children acquire and cement their knowledge, although a chain of real reasoning will absolutely exhaust them.

From this kind of reasoning we conclude that the time-taught method now pursued in mathematics is a reasonable one, that Euclid with the algebra and arithmetic corresponding is in the main advantageous. But why? Because it is conformable to the instincts of pupils, and also because it is historic. But is it conformable enough? Is it historic enough? I think not. Euclid was a grown man in a grown community of very special bent of mind. Where he does not agree with the reason for his inclusion in school curricula he should be neglected. But instead of supplementing him from more recent geometry, it should be from more antique writers and from study of pupils' methods.

Now we come to the bearing of this on the teaching of science. We are comparatively new at this game. We are finding that we have started in too high a key, and we are being recommended to go back. I have not yet seen a recommendation to exactly imitate the mathematical teachers, and go back to Pliny, Geber, Gilbert and Pallissy. But several have advised Boyle and Black. Along with this advice is an insistence on quantitative work from the very start. It appears to me this is a very grave mistake. The use of a rough balance and rough methods of measurement is all that should be aimed at in

school. For example, one teacher of girls proposes to show by furnace and acid that chalk gives off a definite quantity of gas. This seems to me appropriate for an advanced university student, but is not the thing for schools at all.

Experiments to show the indestructibility of matter have this advantage, that you must begin with some matter, and that you must have some appliances on both of which the inquiring mind may feed. But as to where the matter goes to is another matter, and as to what the measurements are all for, you might as well be noting them during the progress of a pantomime.

The same criticisms apply to physiology and botany. It is said we cannot properly study the stomach without a preliminary of histology. If so, they cannot be approached in schools, for histology is a late science and is vain and empty to pupils. The microbes of false ideas are thick in it. But Harvey knew no microscopical histology, and yet he was not altogether a fool. I find boys and girls of fifteen and sixteen studying the alternation of generations in a phanerogam, and not only the nutrition but the respiration of plants. Surely this is pushing on to modern methods with a vengeance. But is there anything gained in development of faculty? Can they *observe* these things, or do they trace a dim something which they are told are there, and recognise them with the wild delight of an irresponsible original researcher? It is the delight of a child who has jumped six feet high with just a little assistance. An independent mind rejects all this and begs for a little exercise in kinds of knowledge which you will find well represented in Pliny.

When we turn back to the books of study which we read as boys of fifteen and sixteen in the times when the ambition to kick a goal or vault ten feet was so strong and so easily ousted other ideas, how many very important laws we find which we then read and now for the first time *know*. I can remember the time when I tried to wake a class to the importance of Boyle and Charles's laws, and I can also remember the time when I remembered that my own old master vainly tried to wake us to it. The result in neither case was thanks, and it was the teachers who were wrong, not the pupils. We do our best, but we are vastly wrong, and we inflict many injustices by force of punishment just as in the old *régime* they broke the rulers over our fathers' shoulders in teaching them practical prosody. A little study of history will lessen this injustice.

At the same time we must distinguish essential historic progress from mere accidents of time. I should be sorry to exclude hydrogen explosions absolutely. JAMES SUTHERLAND.

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Abbe's Optical Theorems.

IN the article, "Optical Science" (NATURE, p. 203), as well as in the preface to Prof. S. P. Thompson's translation of Lummer there mentioned, regret is expressed at the neglect in English text-books of Abbe's contributions to optical theory.

Will you allow me to remark that statements and proofs of Abbe's theorems will be found in §§ 205*b*–205*f* of the 1899 edition of my "Deschanel, Part iv." They occur in the chapter on "Systems of Lenses," and are based on careful study of the writings of Abbe and Czapski.

Ealing, January 9. J. D. EVERETT.

Fireball in Sunshine.

ON Sunday, January 6 last, at 0h. 52m. p.m., a brilliant fireball was seen by many observers in Scotland. The sky was clear and the sun shone brightly at the time. The meteor was observed from Whiteinch Park and Great Western Road, Glasgow, flashing across the north-western sky, and resembling a rocket with a long streaming tail. One correspondent at Glasgow says it travelled from the north-east to west, and that in colour it was like reflected sunlight. Another writer describes it as being of considerable size, "the fiery mass being as large as a bowling ball with a glowing red tail attached." At Killearn, N.B., the object passed from N.W. to W.N.W., and was about 12 degrees above the horizon at the time of its disappearance. It traversed a path of about 20 or 25 degrees, during which it fell about 5 degrees. The radiant of the meteor was probably in Auriga, Perseus, or Aries, so that it belonged to a different system from that which furnished the brilliant daylight fireball of January 9, 1900 (NATURE, January 25, 1900). W. F. DENNING.

Bristol.

Air and Disease.

IN these days of fresh-air treatment, some of your readers may be interested in a quotation from Palladius "On Husbondrie," an early fifteenth century MS. originally in Colchester Castle.

"The longe-woo," says that writer, "cometh ofte of yvel eire," *i.e.* lung-woe or consumption comes often of bad air. The whole verse describes the effects by which you may know bad air or water, and is, perhaps, worth quoting in its entirety.

> "The longe-woo cometh ofte of yvel eire,
> The stomake eke of eire is overtake,
> Take heede eke yf the dwellers in that leire
> Her wombes, sydes, reynes swell or ake,
> If langoure in thaire bledders ough' awake.
> And if thoue see the people sounde and faire,
> No doubt is in thy water nor thin aire."

Thus we are told that both lungs and stomach are affected by bad air and that, to detect bad air or water we are to see whether the inhabitants have aches in stomachs, &c.

The importance attached so early to air and water may, I think, prove worth mentioning, as it is not what most of us would expect. I came across the passage in turning over the leaves of Lodge's edition of Palladius, published by the Early English Text Society. HAROLD PICTON.

Clacton College, Clacton-on-Sea.

RECENT ADVANCES IN THE GEOLOGY OF IGNEOUS ROCKS.

THE closing years of the nineteenth century witnessed a revival of interest in the petrology of igneous rocks, which must be regarded as marking an important stage in the development of that subject. Much detailed work, especially in the laboratories of German universities, during the three or four decades preceding had already accumulated a large body of information; but that work had been confined in great measure to the strictly descriptive side of the science—in short, to what is properly described as petrography—and some of it fell rather into the domain of mineralogy and physical optics than of geology. The value of such a store of material cannot be overestimated; but any tendency which promises to shape it into a connected system must be welcomed by geologists as the breath of life animating the valley of dry bones. Such a movement is undoubtedly felt at the present time, and may perhaps be held to mark the transition in petrology from the stage of observation to that of generalisation. An igneous rock has come to be regarded, more constantly than before, not merely as a mineral-aggregate, but as the product of consolidation of a molten rock-magma; and consideration has been directed to the constitution of such magmas and the conditions governing their consolidation. Recognition of the importance of studying the mode of occurrence of igneous rocks and their relations to one another has led to a closer union of observation in the field with research in the laboratory. Much is being learnt concerning the geographical distribution of the rocks, their connection with crust-movements, and the sequence of eruption of different types at a given centre. The facts thus acquired, and especially the fertile conception of "petrographical provinces," each with its suite of igneous rocks having a community of characters which bespeaks a common origin, have confirmed the conviction that widely diverse rock-types may be evolved from a common parent-magma. Hence arises the problem, to which Brögger and others have boldly addressed themselves, of the processes by which such "differentiation" is effected and the conditions which control them. Hence, too, another problem, a corollary to the former, to frame a natural classification of igneous rocks, based on genetic principles, to supersede the provisional classifications on various artificial or Linnæan schemes which are at present current. The questions involved obviously present great difficulties, and petrologists would be the first to admit that some of

their speculations are of a crude and tentative nature. It is greatly to be desired that students of physical chemistry should turn their attention to petrology; the more so since some subjects, such as the nature of solutions and the constitution of alloys, which have recently been advanced in their hands, may be found to have important applications to the crystallisation of igneous rock-magmas.

Petrological research during the last few years serves especially to emphasise the value of comparative studies of different areas. There are large regions throughout which the igneous rocks show but relatively slight departures from one common type, while elsewhere comparatively small districts exhibit a surprising range of variation. Peculiar rock-types, supposed to be unique and to have the most narrowly restricted occurrence, have in some instances been found to recur at widely separated centres with the same associates and with like geological relations. More generally there are differences as well as resemblances, the rocks of two districts constituting two parallel suites, such that each type in the one suite has its representative in the other. Such a parallelism is that drawn by Brögger between the Monzoni and the Christiania rocks. It points clearly to two somewhat similar, but not identical, parent-magmas having undergone differentiation on similar lines. The investigations of the United States Geological Survey, and of other American geologists, afford numerous illustrations of these and other points. The intrusive masses in the High Plateaux region along the west side of the Rocky Mountains, furnishing, as Gilbert first showed, such beautiful examples of the laccolitic form, are, according to Cross, almost wholly of diorite, diorite-porphyrite, &c. The region lying along, and to the east of, the Rocky Mountains, from Montana to Texas, differing widely from the former belt in geological structure, is equally in contrast with it petrographically. The rocks here are generally richer in alkalies, and they embrace a remarkable profusion of types and varieties. Especially is this seen in the accounts given by Weed and Pirsson of the several mountain-groups of Montana. Some of the rock-types described are new and unique, such as missourite, a leucite-gabbro without felspar; but most of them compare with rocks already known from other areas, though usually presenting points of difference which may be significant. The memoir by Cross and Penrose on the Cripple Creek district, Colorado, may also be cited in the same connection. This district and some of the others alluded to are important mining centres, and it is very interesting to notice how economic geology and what may be termed pure petrology assist one another. Some of the economic questions raised, such as the source and origin of the Montana sapphires (Pirsson, *Amer. Journ. Sci.* 1897, vol. iv. p. 421), may be found to have no unimportant application to the chemistry of igneous rock-magmas.

Since it is not possible in a short article to give even a summary of the actual results of petrological work during late years, we confine ourselves to a few examples. In Britain one result of recent researches, by the Geological Survey and other workers, has been to reveal the occurrence of a number of rock-types hitherto but little known, or wholly unrecorded, in this country. Among them are rocks of the syenite and nepheline-syenite families and the related families of dyke-rocks, some closely comparable, and probably contemporaneous, with the remarkable suite of Devonian intrusions of the Christiania basin. Especially interesting is Teall's brief account of the intrusive masses of Cnoc na Sròine and its vicinity, in the western part of Sutherland. The main mass is found to consist of a quartz-syenite of the nordmarkite type, which graduates on the one hand into a granite, on the other into quartzless syenite, nepheline-syenite, and the rock formerly described under the name borolanite. The last-named rock is composed essentially of orthoclase and melanite garnet with some ægirine-augite and alteration-products of nepheline. A peculiar feature is the occurrence in it of polygonal pseudomorphs doubtless representing leucite, and the rock is practically identical with the so-called leucite-syenite of Magnet Cove in Arkansas. The associated minor intrusions—sills and dykes—are partly of dark hornblendic rocks approaching camptonite, partly of light felspathic rocks containing ægirine, and comparable in different varieties with the grorudite, lindöite, &c., of the Christiania district. The distribution and petrography of the Scottish lamprophyres and the peculiar felspathic rocks which seem to be their natural complements are as yet imperfectly known; but Flett, *Trans. Roy. Soc. Edin.* (1900) vol. xxxix., p. 865, has described from the Orkneys dykes of bostonite, camptonite, monchiquite and alnöite, and some of these types are known to be represented in various parts of the Highlands. Camptonites and augite-camptonites are described by Hill and Kynaston in Argyllshire, where they are genetically related to another remarkable rock-type, kentallenite, which in its association of alkali-felspar with olivine and augite resembles the olivine-monzonite of Predazzo. The kentallenite itself is related to, and occurs in part as a marginal facies of, the large granite and tonalite masses of the district. This is only one example of the very heterogeneous nature of the intrusions marked on the geological maps of Scotland as granite. The same variability characterises them from the Galloway "granites," recently described by Teall in a Survey Memoir, to the large intrusion of Aberdeen, where the extreme basic modifications are represented by troctolite and peridotite (bastite-serpentine). An interesting group of minor intrusions, as yet only partially described, includes the orthophyres, lamprophyres, and quartz-basalts of South Devon. Finally we may mention a unique rock described by Judd (*Trans. Roy. Irish Acad.* (1897) vol. xxxi. p. 48), and named rockallite after the the remote islet where it occurs. It is a peculiar granite-porphyry consisting of ægirine, quartz and albite; differing from Brögger's grorudite, and from other acid rocks, in its remarkable richness in iron and poverty in alumina and in the absence of potash.

One point worthy of remark is the way in which various crystalline rocks, to which more or less of obscurity has attached, are being reclaimed from the limbo of "gneisses," "granulites," &c., and recognised, some as true products from igneous fusion, others as metamorphosed sediments. A recently published memoir by Holland (*Mem. Geol. Surv. India* (1900), vol. xxviii.) establishes the igneous origin, and describes the petrographical characters, of an important group of Archæan rocks in southern India. We may note incidentally, as illustrating the increasing hold which the idea of genetic grouping is obtaining among petrologists, that the author boldly uses the name "charnockite series" for an assemblage of types ranging in composition from acid to ultrabasic. Their community of origin is attested not only by their intimate association but by remarkable points of resemblance which run through the whole series. The constant presence of hypersthene in the rocks is one characteristic, and the common acid type, to which the name charnockite is given, is in fact a hypersthene-granite. The component minerals exhibit an astonishing freshness of preservation. Since rocks generally similar have been described, under such names as pyroxene-gneiss, pyroxene-granulite, &c., as occupying very extensive areas in Peninsular India, Ceylon, and Burma, a proper appreciation of their nature and origin is a matter of considerable importance.

Microscopical research and chemical analysis, as representing, on the side of the laboratory, the groundwork of all our knowledge of rocks, must necessarily retain the important position which they occupy; and in both fields improved methods are coming into general

use, which impart increased precision to the results. Michel-Lévy's elaborate discussion of the optical properties of the felspars has greatly facilitated the discrimination of the several varieties; while among special instruments we may recall Fedorow's "universal theodolite," enabling accurate optical measurements to be made on crystals in random sections. The application of dense liquids to determine the specific gravity of minute fragments of minerals, and to obtain pure material for analysis, has been perfected, and, especially in the form of Sollas's "diffusion column," has been made both simple and convenient for use. The importance of accuracy and completeness in the chemical analysis of rocks has become more generally recognised. Many of the most valuable rock-analyses published in late years are due to the United States Geological Survey, who have realised the importance of maintaining an adequate staff of skilled chemists. One point brought out is the wide distribution in igneous rocks of small amounts of the heavy metals, and of some other elements, such as barium and strontium. Apart from its obvious application to questions concerning the origin of metalliferous deposits, information of this kind will probably be found to throw some light upon matters of more strictly petrological interest.

THE DISAPPEARANCE OF IMAGES ON PHOTOGRAPHIC PLATES.

IT is the aim of the modern astronomer to employ photography, whenever possible, in the many branches of his work, as by this means the peculiarities of the observer are eliminated and a permanent record is obtained that can be examined at leisure at any later date. In some kinds of work photography helps us in obtaining a great number of facts in a very short space of time, facts which would have taken weeks to accumulate by the old method of eye observation. Not only is the science more rapidly advanced by the greater abundance of material at hand, and therefore available for discussion, but the application of photography to astronomy has opened up so many new fields of work that the whole subject has now a far wider horizon than before.

To be able to photograph in a few hours objects which for ever will be outside the reach of the human eye, however aided, is one of the many marvels of this invaluable method.

The fine photographs obtained to-day, and so well illustrated in our books by the aid of the modern processes of reproduction, suggest the importance of recording the appearances of these celestial objects after some years have elapsed, in order to be able to note whether any changes in brightness or form are occurring. The magnificent work of the "Carte du Ciel," started by the far-seeing mind of Admiral Mouchez, is one of those schemes on a large scale for obtaining a survey of the universe at the close of the nineteenth century. The many thousands and thousands of photographic plates that will have been exposed to the sky when this plan will have been accomplished point out to us the immense importance that must be attached, not only to the "*keeping*" qualities of the film on the glass plates, but also to the retention of the *images* on these films.

Since one of the chief objects of Admiral Mouchez's plan was to hand down to posterity a chart of the celestial vault as recorded in our time, to enable those that follow us to compare with it that recorded in their time, the importance of the preservation of the photographic films, and the images impressed on them, cannot be overrated.

Most of the readers of NATURE are familiar with those beautiful photographs of long exposure of nebulæ and star clusters which we owe to the skill and patience of Dr. Isaac Roberts, and which he has given to the world in two magnificent volumes of plates. In the second of these volumes Dr. Roberts makes some very interesting and valuable remarks regarding the "fading" of some of the images on the photographic plates, and his experience shows that such disappearances of images after long intervals of time may assume very considerable proportions.

Although the period over which his experience extended only covered about ten years, this interval of time was sufficiently long to enable him to obtain some very striking facts.

The following brief summary of the two instances which he recorded in his second volume will give the reader a general quantitative idea of the disappearances of images during a short period.

A photograph of a region of the sky was taken on February 15 in 1886, and 403 star-images were counted on the negative. A re-count on May 29, 1895, found only 272 images, a loss of 131 images in about nine and three-quarter years.

Again, another photograph of identically the same region, taken on March 22, 1886, recorded 364 stars; the same plate, examined in May 1895, showed only 234.

These facts, then, indicate that, even after so short a period as ten years or so, the photographic film cannot be depended on, and that for lasting purposes recourse must be made to some means of reproducing the photographs soon after they have been obtained, the reproductions being as faithful to the originals as possible. It is generally known that, in nearly every method of reproduction, very faint details are lost in the process, but this loss could be easily recorded by noting the slight differences at the time; printed on good paper and with permanent ink, such reproductions should be lasting.

The fact that the great photographic chart of the sky is approaching completion causes one to think of the great expense that will be involved in reproducing the large number of individual plates. That many of the observatories which have taken part in this undertaking will find some difficulty in at once getting together the necessary funds is quite possible, so that a delay of a few years may be detrimental to the accuracy of the chart.

It is therefore very important that some means should be at hand to prevent the images of the fainter objects from fading quite away, or, if already disappeared, to bring them back to view.

Fortunately, the latter alternative can be accomplished by a process of manipulation which we owe to Sir William Crookes.

The completeness and success of this method will be gathered from the fact that when Sir William Crookes had "revived" one of Dr. Roberts' negatives that had entirely lost many images, the latter, on re-counting, "found that every one of the missing images had been restored to view, as distinctly, I think, as they were after the negatives were first developed."

The process by which Sir William Crookes accomplished this has been published in detail by Dr. Roberts in the *Monthly Notices* of the Royal Astronomical Society (vol. lxi., No. 1) for last November. As the description should prove of interest and service to many of our readers, the following account is appended, as described by Sir William Crookes himself in a letter to Dr. Roberts.

"(1) Soak the plate for three hours in distilled water.

(2) Prepare, in advance, two solutions A and B.

Solution A.		Solution B.	
Pyrogallic acid	1 oz.	Sodium carbonate (crystals)	12 oz.
Sodium metabisulphite	1 oz.	Sodium sulphite	4 oz.
Water	80 oz.	Water	80 oz.

"Mix equal parts of A and B, and allow the plate to soak in the mixture for ten minutes or a quarter of an hour, in the dark. Wash well.

"(3) Transfer the washed plate to a solution of three oz. of sodium hyposulphite in 20 oz. of water. Allow it to remain for half an hour, and then wash the plate in running water for three hours.

"(4) Prepare a 'clearing' solution according to the following formula:—

Alum	1 ounce
Citric acid	1 ounce
Ferrous sulphate	3 ounces
Water	20 ounces

"Allow the plate to soak in this for ten minutes, and then remove and wash in running water for six hours.

"(5) Prepare in advance two solutions, C and D.

Solution C.		Solution D.	
Ammonium sulpho-cyanide	100 gr.	Gold chloride	15 gr.
Water	100 oz.	Water	15 oz.

"For use take 1 ounce of each, and add 8 ounces of water. Soak the plate in this mixture for ten minutes, and at the end of the time remove and wash it in running water for half an hour. Transfer to a dish of distilled water, where it may remain for an hour. Finally, drain on blotting-paper, and allow to dry.

"The separate solutions, A, B, C and D, will keep for an indefinite time, and the same may be said of the clearing solution, if kept tightly corked. But when mixed together they will not keep, so fresh mixtures should be made each time.

"I have given you the full process adopted on the plates you sent me, but I think some of them may be omitted with no disadvantage. For example, I should like to try if the soaking in hyposulphite may be dispensed with. I think it can, but I only tried leaving it out on the plates you sent that had not faded.

"I always found the great secret of preventing images from fading out was to wash them very well in running water. The clearing solution allows the time of washing to be a little shortened, but not much.

"The sulphocyanide and gold solution has the property of precipitating gold on the image, and rendering it of a blacker colour and diminishing the chance of fading. I should think you will find it useful always to use the clearing solution and the sulphocyanide and gold solution in your usual process." WILLIAM J. S. LOCKYER.

VIBRATION OF GUN-BARRELS.[1]

THIS research on the vibration of gun-barrels is a continuation of former investigations on the nature of vibrations set up in a gun-barrel when fixed, with a view to discover how the *error of departure* is affected by rapid oscillations of the barrels when firmly clamped.

The authors' experiments were made on three small-bore rifles, placed at their disposal by the firm of Mauser—viz., one 8 mm. experimental rifle furnished with a wood stock, one 7 mm. Spanish model, and one trial gun 6 mm.—in all cases smokeless powder was used. In their early experiments the rifles were clamped firmly when fired, but in their recent work this method of support was abandoned, as they found that the clamping imposed restraints which altered the character of the shooting of the rifles and also their mode of vibration. This is by no means a new discovery. The late W. E. Metford, of well-known rifle repute, showed long ago (1870) that the shooting of a rifle was greatly changed when the barrel was securely clamped to a heavy mass of iron. In order to avoid this source of trouble the experimental guns were sometimes embedded in cork and sometimes suspended pendulum fashion by ropes, so that they were practically unrestrained and the condition of support approximated to the normal one, namely, the rather free support of the hands and shoulder of the marksman. The movements of the barrels were recorded by means of photography on a moving sensitive plate. Two methods were employed for firing the guns, viz., an electro-magnetic trigger-puller, and a pneumatic method in which a small piston, moving in a cylinder attached to

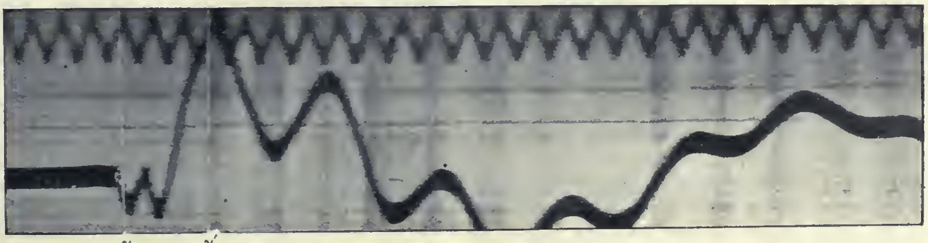


FIG. 1.—8 mm. Cal. gun clamped in cork support. Vibration curve of a point at the muzzle. γ Disengaged spark at the instant at which the shot leaves the muzzle; γ′ Disengaged spark at 4·5 m. distance from the muzzle. In the unconstrained method of holding the weapon, the amplitude of the vibration is not so strongly marked as when it is clamped. (See Fig. 2.)

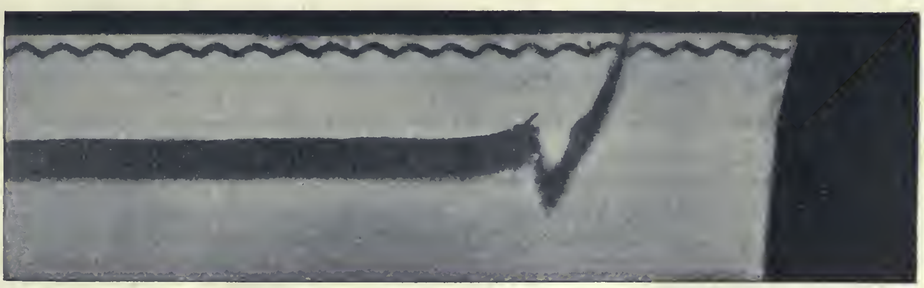


FIG. 2.—Gun 7 mm. Cal. Held by means of artificial marksman, and fired by pneumatic method.

[1] "Untersuchung über die Vibration des Gewehrlaufes." Von C. Cranz und K. R. Koch. Pp. 23; 4 plates. (München, 1900.)

the trigger-guard, moved the trigger. This pneumatic method was employed by the authors of the paper because it introduced no vibration when acting, and the method is strongly emphasised by the writers, who apparently have overlooked the fact that an exactly similar method has been in use in England for the last seven years in connection with the Tram chronograph used in ballistic work. Since the pneumatic method of firing introduces no vibration, it could be used in connection with a gun slung by ropes.

An attempt is made to show nodal points of vibration by means of sand figures, after the manner of Chladni, and sand curves were produced on a surface attached by cement to the guns when clamped and also when supported loosely, and also in the case of a barrel used without a stock. The vibrations appeared to be approximately the same in each case. The research concludes with a list of results, and it is stated that in the case of the 6 mm. gun the exit of the shot takes place just before the completion of the first quarter vibration of the first appearing second over tone. The research, although presented in a form almost too much condensed in parts to be quite clear, is of considerable interest, and has evidently been conducted with care and patience.

I wish to take this opportunity of acknowledging the kind assistance given me by Mrs. Max Schiller in connection with some portions of the authors' work on ballistics. F. J.-S.

THE ROYAL INDIAN ENGINEERING COLLEGE.

It is evident from the letters and comments which have appeared in the *Times* and other papers, that the summary notice of dismissal of a large part of the scientific staff of the Royal Indian Engineering College, Coopers Hill, is regarded as an act of injustice which, if permitted to take effect, would be distinctly detrimental to the interests of science. The facts of the case were stated in these columns last week, and an examination of them is sufficient to convince any one that the seven gentlemen who have received notice that their services will not be required after the end of the Easter term have been treated with little courtesy and no consideration. That it should be possible for men of scientific eminence to be dismissed from their posts more easily than if they were civil service messengers or clerks, is one of the many indications we have of the small value attached by the official mind to scientific work and distinction. Perhaps Lord Kelvin's letter, which we reprint below from the *Times*, will show that the matter is not to be permitted to rest in its present unsatisfactory position.

Sir,—The correspondence which appeared in the *Times* of January 3 regarding Coopers Hill College has caused a painful shock to all who know of the good work which the college has done in giving to India the benefits of well-trained engineers in the service of its Government. No one can read that correspondence, I believe, without being convinced that the seven professors and teachers whose position is threatened are justified in asking for an inquiry.

The proposed action—a sudden and arbitrary dismissal of able and distinguished scientific teachers who have been doing duty for periods of nine to thirty years in a satisfactory manner—is certainly not to be expected in institutions under the control of the British Government; and I sincerely hope that the Secretary of State for India in Council will see his way to granting the request for an inquiry.

I am your obedient servant,
Kelvin.

Netherhall, Largs, Ayrshire, January 11.

The principle of the action is as bad as the private injury, for it suggests that gentlemen of education and distinction, who have held Government posts for long periods, may have their services dispensed with at the will of a military officer having no special qualifications to enable him to know the value of their work. If there is no more security of tenure for scientific men than is implied in the act of the president of the College at Coopers Hill, it is because they have not asserted their rights with sufficient insistence, and the sooner they do so the better it will be for their positions. Opportunity for showing that the gentlemen who have been instructed to give up their appointments at Coopers Hill have the world of science behind them will be afforded by a memorial in their favour which we hear is being prepared, to be submitted to the Secretary of State for India.

No excuse worthy of consideration has been offered for the dismissal of half the educational staff of the College. The salaries of the gentlemen who have received notice —for that is what it amounts to—are by no means too liberal, so that the statement that the action has been taken with a view of reducing expenses seems altogether insufficient. As "M. A." shows in the *Times*, money is available for the needs of the College, and "it is the worst form of economy to starve the staff of a teaching institution." Another writer goes even further, for he asks, "Is it not the case that the college has been for some years self-supported by fees from students?" But, putting this question aside, we have no hesitation in saying that the work done by the gentlemen dismissed could not be carried on with the present efficiency at less cost. In any case, the method adopted is not the one best calculated to improve the efficiency of any institution.

There is one other point, and it is not the least important. Assuming that the president of the College is able to dismiss arbitrarily as many members of the staff as he cares to dispense with, then some substantial compensation should be given to those thus compulsorily retired. Dr. Johnstone Stoney mentions in the *Times* that "when, twenty-one years ago, the Government through Parliament gave Ireland an Examining Board in place of a University, it allotted when doing so the full amounts of their salaries or emoluments as compensation for loss of office to the outgoing members of the staff of the late Queen's University and to those professors of the University who were required by their statutes to discharge University as well as college duties." This principle should be brought to the front and urged upon all who have the control of institutions like that at Coopers Hill, namely, that adequate compensation for loss of office must be awarded to the members of the staff who have to retire after years of good service.

NOTES.

Sir Archibald Geikie will shortly retire from his post of Director-General of the Geological Survey of the United Kingdom. He will be entertained by his friends at a complimentary dinner early in March. All who wish to attend should communicate with Mr. F. W. Rudler, Museum of Practical Geology, 28, Jermyn Street, London, S.W.

The death is announced, at seventy-eight years of age, of Prof. Hermite, the eminent French mathematician. He was a member of the Academy of Sciences and a Foreign Member of the Royal Society. Announcement is also made of the death of M. Chatin, the botanist, and a member of the Paris Academy of Sciences.

The Geological Society will this year award its medals and funds as follows:—The Wollaston medal to Mr. Charles Barrois, of Lille; the Murchison medal to Mr. A. J. Jukes-Browne, of Torquay; the Lyell medal to Dr. R. H. Traquair, of Edinburgh; and the Bigsby medal to Mr. G. W. Lamplugh, of the Geological Survey. The Wollaston fund goes to Dr. A. W. Rowe, the Murchison fund to Mr. T. S. Hall (Melbourne), and the Lyell fund to Dr. J. W. Evans and Mr. A. McHenry.

THE Council of the Manchester Literary and Philosophical Society have awarded the Wilde Medal for 1901 to Dr. Elias Metchnikoff, of the Institut Pasteur, Paris, for his researches in comparative embryology, comparative anatomy, and the study of inflammation and phagocytosis; and the Wilde premium to Mr. Thomas Thorp, for his paper on grating films and their application to colour photography, and other communications made to the Society. The Dalton Medal for 1901 has not been awarded. The presentation of the Wilde medal and premium will take place on February 5, when Dr. Metchnikoff will deliver the Wilde Lecture on "La Flore microbienne du Corps humain."

IN connection with the dispute between the Kew Observatory and the London United Tramways Company, it was mentioned in a note in our last issue that the double trolley system was in successful operation in America. The tramways referred to are at Cincinnati, and they were originally compelled to adopt this system by the Telephone Company, which successfully opposed their allowing waste current to leak into the earth. Over two hundred miles of track are thus equipped, and the managers find, after ten years running, that the cost of maintenance is considerably reduced in consequence. This seems in itself a sufficient answer to the London United Tramways Company, who urge that it is impossible to adopt the double trolley system. It is interesting to note that the advocates of earth returns are not in agreement amongst themselves. On the one hand, the London United Tramways Company claims that there is already a potential difference between their rails and earth, greater than the maximum accepted by Kew, due to leakage currents from the Central London Railway. On the other hand, the *Electrician*, in a note in the issue of January 11, maintains that the return current in a deep level railway cannot escape from the tunnel and rise to the surface in sufficient quantity to be observable by any but a mathematician. We are afraid the engineers of the Tramways Company will not regard this as a very welcome contribution to their side of the argument.

THE twenty-eighth annual dinner of old students of the Royal School of Mines will be held at the Hotel Cecil on Wednesday, February 6. The chair will be taken by Sir G. Stokes, senior past professor of the Royal School of Mines, and Sir W. Roberts-Austen will act as vice-chairman. In view of the fact that this year is the jubilee year of the School, it is expected that a large number of old students, as well as past and present professors, will be present at the dinner.

THE president of the Röntgen Society has placed at the disposal of the Council a gold medal to be awarded to the maker of the best practical X-ray tube for both photographic and screen work. The competition is open to makers in any country. Tubes intended for competition must be sent in addressed to the Röntgen Society, 20 Hanover Square, London, W. The package should contain the full name and address of the sender, and must reach the Society not later than May 1.

THE Turin Académie royale des Sciences announces that a Prix Bressa of 9600 francs (384*l.*) is open to competition among investigators and inventors of all nationalities. The prize will be awarded to the person who, in the opinion of the Academy, made the most brilliant or useful discovery in the four years 1897–1900, or who produced the most celebrated work in pure or applied science. Works intended for consideration in connection with the prize must be sent to the President of the Academy before the end of next year. The right is reserved to award the prize to an investigator whose work is considered to be the most distinguished, even though he does not submit an account of it.

THE Rome correspondent of the *Times* states that under the auspices of the Italian Geographical Society, and in the presence of the King and Queen of Italy, the members of the Royal Family, the Diplomatic Corps, the Ministry, and an audience composed of the principal personages of Roman society, his Royal Highness the Duke of the Abruzzi delivered a lecture on Monday upon his Polar expedition, in the great hall of the Collegio Romano. Captain Cagni, who commanded the sledge party, then succeeded the Duke of the Abruzzi at the desk, and related the story of the dangers and difficulties successfully overcome in planting the Italian colours furthest north at 86° 33′ north latitude.

A ROYAL Commission has been appointed to make investigations respecting the beer-poisoning epidemic. The Commissioners are:—Lord Kelvin, Sir W. Hart Dyke, Sir W. S. Church, president of the Royal College of Physicians, Prof. T. E. Thorpe, Mr. H. Cosmo Bonsor, and Dr. B. A. Whitelegge. Dr. G. S. Buchanan, one of the medical inspectors of the Local Government Board, is the secretary to the Commission. The instructions to the Commissioners are:—To ascertain with respect to England and Wales (1) The amount of recent exceptional sickness and death attributable to poisoning by arsenic; (2) Whether such exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, and, if so, (*a*) To what extent; (*b*) By what ingredients or in what manner the arsenic was conveyed; and (*c*) In what way any such ingredients became arsenicated; and (3) If it is found that exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, by what safeguards the introduction of arsenic therein can be prevented.

IT is to the credit of the members of the medical profession at Colchester that they have decided to show how they honour the memory of Dr. William Gilbert, the famous physician to Queen Elizabeth, whose work, "De Magnete," published three hundred years ago, constitutes the bed-rock of modern knowledge of magnetism. The intention is to erect a full-length marble statue of Gilbert in a niche in the main façade of the new Town Hall at Colchester, the city in which he was born, and where his remains are buried. Already the sum of 130*l.* has been contributed by the medical men of the borough, and as the minimum amount required is only 150*l.*, it will no doubt soon be subscribed. Gilbert's work is, however, so widely known and appreciated that it is almost a pity to neglect the opportunity to make the memorial a national one. The medical men of Colchester are to be congratulated upon the initiative they have taken, but there are many other men of science who would like to see that the memorial to be erected is a worthy testimony of the regard in which Gilbert's work is held in the whole scientific world. The treasurer of the Colchester committee is Mr. Henry Laver.

A BRITISH Congress on Tuberculosis will be held in London on July 22–26, and will be opened by the Prince of Wales. There will be four sections, with presidents as follows:—I. State and Municipal, Sir Herbert Maxwell, Bart. II. Medical, including Climatology and Sanatoria, Sir R. Douglas Powell, Bart. III. Pathology, including Bacteriology, Prof. Sims Woodhead. IV. Veterinary (Tuberculosis in Animals), Sir George Brown, C.B. Every British Colony and Dependency is invited to participate by sending delegates; while the Governments of countries in Europe, Asia and America are invited to send representative men of science, and others, who will be the distinguished guests of the Congress. The information already gained, both at home and abroad, shows that consumption and other forms of tuberculosis, although preventable and controllable by intelligent precautions, still remains the direct cause of a high rate of death and sickness. In the United Kingdom

alone some 60,000 deaths are recorded annually from tuberculosis, and it is stated on good authority that at least thrice this number are constantly suffering from one form or another of the disease. The object of the forthcoming Congress is to exchange the information and experience gained throughout the world as to methods available for stamping out this disease. Papers wlll be read, and clinical and pathological demonstrations will be given; while the museum, which is to be a special feature of the Congress, will contain pathological and bacteriological collections, charts, models, and other exhibits. The address of the General Secretary of the Congress is 20, Hanover Square, London, W.

PROF. P. K. E. POTAIN, whose death we regretfully announced last week, at the age of seventy-five years, delivered his last lecture on clinical medicine at the Charity Hospital about six months ago. His treatises on diseases of the heart and lectures on clinical medicine are renowned both among physiologists and medical men. Referring to his death at the meeting of the Paris Academy of Sciences last week, M. Marey remarked that Prof. Potain developed the means of diagnosis, and showed how various sounds characteristic of diseases of the heart should be interpreted. Not only was he able to determine with precision any injury or morbid change in the exercise of functions of organs; he showed also that the disorders themselves revealed the interrelations between such functions, that, for instance, diseases of the liver and the kidney have echoes in the heart, and that pulmonary tuberculosis prevents the development of certain cardiac lesions. He was a master of clinical medicine, and an excellent physiologist, as well as a renowned physician. He devised an ingenious colorimetric method for testing certain substances, and his sphygmometei for the measurement of arterial pressure is still among the best. Prof. Potain was a member of the Paris Academy of Medicine, a member of the Academy of Sciences, and Commander of the Legion of Honour.

CUPELLATION is one of the most ancient of metallurgical processes, and was well known at least as early as the year 600 B.C. It was used by the Romans to extract silver from its ores in Spain and at Laurion, but it has been hitherto supposed that the hearths of their furnaces were made of comparatively non-absorbent materials, such as clay and marl, the litharge and other oxides being skimmed off or allowed to flow away in side channels. It is now shown, however, by Mr. Gowland, in a paper read before the Society of Antiquaries in May last, that a silver refinery was worked at Silchester in which argentiferous copper was cupelled on hearths made of bone-ash. Bone-ash has the property of absorbing molten litharge and some other oxides as readily as blotting-paper absorbs water, and apparently only its high cost prevented its use by the Romans in all their later cupellation furnaces. Careful examination of the remains found at Silchester convinced Mr. Gowland that the work there resembled some of the operations formerly practised in Japan, and that it is probable that it consisted in the recovery of the silver from Roman copper coins issued in the third century A.D. The metal contained 4 per cent. of silver, and was cupelled in three furnaces in succession with the aid of repeated additions of small quantities of lead.

DR. R. MINERVINI, of the University of Genoa, has published recently, in the *Zeitschrift für Hygiene*, the bacteriological investigations he has made of samples of air and water collected in mid-ocean during a trip from Genoa to New York and back. He finds more bacteria in air at sea than did Fischer in his classical investigations. Out of 42 determinations, however, 6 yielded no bacteria, whilst the highest number found in a volume of 27 litres of air was only 17. As was to be expected, he obtained the best results after heavy rain. No pathogenic bacteria were discovered. It is unfortunate that as regards the author's water examinations his stock of apparatus did not permit of his cultivating the samples at once after collection, but compelled him to keep them from seven to ten days until he landed. This fact deprives his quantitative results of their value. The report of the German deep-sea expedition, carried out during 1898–99, is awaited with great interest. It will be remembered that the German man-of-war *Valdivia* was placed at the disposal of the members by the Government, and it visited the African coasts as well as the Indian and Antarctic Oceans, and bacteriological investigations were included in the work of the expedition.

THE contents of the Cape *Agricultural Journal* (November 22, 1900), which has just reached us, testify to the widespread interest which is being taken in scientific agriculture in Cape Colony. Among subjects dealt with are the liming of soils, selection of seeds, merinos, rhubarb and mealie culture, "raising" calves without milk, and wide *versus* narrow waggon tires. The report for 1899 of the Colonial Bacteriologist is also inserted, and in it Dr. Edington describes a method for protective inoculation against horse-sickness, which is as follows:—Animals which have passed through an attack of the disease and have recovered are inoculated at intervals with increasing doses of virulent blood taken from affected horses. After this treatment the animals are bled and the serum preserved. Blood of the highest virulence is likewise obtained, standardised against the serum and preserved. A definite amount of the virulent blood is mixed with 50 c.c. of serum and injected subcutaneously. Some days later 30 c.c. of the same serum, with the same dose of blood, is injected. At a later date the procedure is repeated with a reduced dose of serum, and fourteen days later pure virulent blood is injected. This method is said to afford a perfect and complete solution to the problem of protecting horses which have to live in unhealthy districts in South Africa, and is very similar to that devised by the Imperial Bacteriologist of India against rinderpest, as mentioned in these notes on December 13 (p. 161).

IT is to be feared that it will be a long time before the general public realises what is desirable and what undesirable in artificial lighting. The two principal desiderata are well distributed, but not necessarily very brilliant, illumination, and cheapness, which means high efficiency and consequently high intrinsic brilliancy of the source of light: two characteristics in direct antagonism. The use of some form of diffusing shade is therefore desirable, even with the present electric lamps; and it will be essential when lamps of higher efficiency come on the market, as is sure to occur before long. Mr. W. L. Smith's experiments ("A Study of Certain Shades and Globes for Electric Lights as used in Interior Illumination," *Technology Quarterly*) are a timely and very valuable contribution to our knowledge of the relative merits of various types of shade. For a shade to be satisfactory, it should soften down and distribute evenly the light of the naked lamp, whilst, at the same time, it should not absorb too great a proportion of it. Mr. Smith's experiments show that this problem is solved by very few of the shades in ordinary use. It is worthy of remark that the author finds that the Holophane shades, in which the cutting of the glass is determined on scientific instead of artistic principles, are greatly superior to all others. We have seen a Nernst lamp (which is, with the exception of the arc, the most intense form of artificial illuminant) burning in a Holophane globe, and can fully endorse Mr. Smith's remarks on the excellent manner in which these globes soften and diffuse the light. It is to be regretted that the author has not drawn more distinction between globes designed to cover the lamp and shades merely intended to be hung over it, as direct comparison of the two classes is hardly fair.

The pamphlet, short though it is, contains many suggestive results, and we await with interest the promised account of further experiments.

IN the *Physical Review*, xi. 5, Mr. W. P. Boynton gives an investigation of the form of Gibbs' thermodynamic model for a substance following Van der Waals' equation, and compares this model with that given by Maxwell.

PROF. ANTIGONO RAGGI, writing in the *Rendiconti* del R. Istituto Lombardo, xxxiii. 17, gives a summary of the works of Serafino Biffi, who died on March 27, 1899. Biffi was the author of many valuable contributions to medical and physiological science, and we are glad to learn that his collected works are shortly to be published.

A PHYSICAL theory of nerve is given by Mr. W. M. Strong in the *Journal of Physiology* (xxv. 6). The theory, which is based on the ionic theory of salt solution, assumes all nerves to consist of a semi-solid axis cylinder containing a saline substance in solution. The salt is wholly or partially ionised, so that the axis cylinder is a good electrolytic conductor. Surrounding it is a medullary sheath or outer layer formed of a relatively bad conductor. The negative ion of the salt is supposed to be of a simple nature and to move freely in the semi-solid material of the axis cylinder, while the positive ion only moves with great difficulty. The contraction of a muscle, the author supposes, is directly caused by the arrival of the negative variation at the point where the nerve terminates in the muscle.

THE tenth volume of scientific memoirs edited by Prof. H. Crew and published by the American Book Company, contains reprints of the more important treatises dealing with the "wave theory of light." Beginning with the work of Christian Huygens, the first three chapters of his "Treatise on Light" (1678) are given, describing rectilinear propagation, laws of reflection and refraction; concluding this section is a biographical sketch of the life of Huygens. Next are given three of the historical contributions of Dr. Thomas Young, on the "Theory of Light and Colours," "On the Production of Colours," and "Experiments and Calculations in Physical Optics," followed, also, by a short biographical sketch of the author. The volume is concluded by memoirs of Arago and Fresnel on the "Diffraction of Light" and "Action of Polarised Light," a biography of Fresnel, and a bibliography of the literature at present available on the subject.

WE have received a copy of a report on Hertzian waves drawn up for the recent Physical Congress at Paris by Prof. Augusto Righi, of Bologna. The report deals with the subject from two points of view; the theoretical aspect, which considers the physical identity of Hertzian waves and waves of light, and the practical aspect in connection with wireless telegraphy. Prof. Righi's paper is divided into four sections, the first containing a description of the apparatus used in connection with the production and study of Hertzian waves, the second with radio-conductors, the third with the optical properties of electrical oscillations, and the last with Hertzian telegraphy. Prof. Righi's intimate knowledge of the subject and the important part he himself is known to have played in connection with the invention of wireless telegraphy have eminently qualified him for furnishing physicists with a brief summary of the progress made in this branch of physics since it was first opened up by Hertz.

THE December number of the *Photo-Era*, the American journal of photography, contains many articles of interest. Mr. Yellot reviews the third "Philadelphia Photographic Salon," and evidently does not think very much of it, as he talks of the . . . "dreary monotony about the tier on tier of weak, fuzzy, washed-out-looking photographs. . . ." Landscape composition is another communication worth perusing. Under the heading "Photographing the Aurora," Mr. Stiles describes and illustrates the photograph he obtained at Mount Washington. He used a Ross-Goerz six-inch lens, aperture 7·7, and isochromatic plates, and gave an exposure of 35 minutes. He writes: "What is surprising is the actinic power of the auroral light as compared with the bright moonlight on the snow. Under the aurora is a dark space, which is noted in many displays. This in earlier notes on the aurora was assumed to be dark by contrast, but the photograph shows a quite definite lower boundary."

WE have received from St. Xavier's College Observatory the monthly meteorological results for the months of January to June for the thirty-three years 1868–1900, which we are glad to see will shortly be followed for the other six months, ending December last. The observatory was established in August 1867, and is situated one and a half miles north-east of the Alipore Observatory, and is sufficiently isolated for trustworthy observations. The instruments have been compared with those at either Kew Observatory or the Government Observatory at Alipore, and the observations have been carefully taken several times daily by the fathers in charge, so that the tables form a a very valuable series.

MESSRS. ELSTER AND GEITEL have sent us some further accounts of their interesting experiments on atmospheric electricity. In No. 8, vol. ii. of the *Physikalische Zeitschrift*, papers are communicated on the measurement of electrical leakage in free air, and in closed spaces. Dr. Geitel finds that with regard to the air in a closed vessel, with an initial charge of 240 volts (independently of the sign of electrification) the leakage from an insulated body amounted to about 0·4 per cent. per minute; on the second day the leakage amounted to 1·0 per cent., and on the fourth day to 1·4 per cent. After this period the leakage became slower, and gradually attained a limit of about 2 per cent. per minute. A full description is given of the apparatus employed. He also found that the leakage was not proportional to the charge of electricity, but that for charges varying from 80 to 240 volts the amount remained constant. This phenomenon was pointed out by Matteucci in 1850 (*Annales de Chémie et de Physique*, vol. xxviii.), but the observation remained practically unnoticed. Further, Dr. Geitel found that the influence of daylight, or of artificial illumination, was not perceptible on the results obtained.

THE new number of the *Abhandlungen* of the Vienna Geographical Society consists of an exhaustive paper on the cork-tree, by Eugen Müller. The botany of the cork-tree and the growth and chemical constitution of the cork are first discussed; then follow a lengthy investigation of the geographical distribution of the cork-tree, a history of the production of cork, and a statistical account of the development of the world's trade in cork.

PROF. MITZOPULOS contributes a paper on two of the most remarkable of the seismic disturbances experienced in Greece during the years 1898 and 1899, to *Petermann's Mitteilungen*. The first, the Tripolis earthquake of June 2, 1898, Prof. Mitzopulos believes to have been caused by subterranean falls of rock. The second, or Triphylia earthquake, occurred on January 22, 1899; its epicentrum is located in the Ionian Sea, some 35 to 40 kilometres to the west of the coast of the Peloponnesus, where the bottom goes down in terraces to depths of 2500 to 3500 metres. The epicentrum was probably about 70 kilometres below the sea-bottom.

THE greater part of the December number of the *National Geographic Magazine* is devoted to an account, by Mr. Wilbur C.

Knight, of an expedition to the fossil fields of Wyoming in July 1899. This expedition was organised by the general passenger agent of the Union Pacific Railroad, who issued invitations to every important university, college, and museum in the United States. Each institution was allowed one professor and one or two assistants, who were given free transport from Chicago to Laramie and back. About one hundred men of science joined the expedition, which collected an immense amount of valuable material, including many photographs of geographical interest, some excellent specimens of which illustrate Mr. Knight's article.

WE have received the first number (January 1, 1901) of the *Geologisches Centralblatt*, which is a new fortnightly geological review intended to give titles and brief abstracts relating to all books, papers, maps and tables that have been published on geology, including palæontology and petrography. Twenty-four numbers of thirty-two pages each will be issued yearly. All works issued since April 1, 1900, will be noticed. In the present number there are notices of 104 works, consequently we may expect about 2500 articles to be recorded during the year. We may remark that in the first volume of Whitaker's "Geological Record" for 1874, there were more than 2000 entries, while in Blake's "Annals of British Geology" for 1893 there were 730 entries. The *Geologisches Centralblatt* will not, however, take notice of articles on pure mineralogy and crystallography. It starts with a good list of supporters and contributors, amongst whom are Barrois, Choffat, Reusch, F. D. Adams, and many others, and we observe that British abstracts are furnished by Mr. C. V. Crook, of the Geological Survey Library in Jermyn Street. Abstracts appear in German, English and French. The titles of works in other languages will be translated into one of the before-mentioned languages, and appear beneath the original titles. The *Centralblatt* is divided into sections, but the authors under these sections are arranged promiscuously. The abstracts extend occasionally to a page or even two pages in length; some occupy but a single line. New species of fossils are printed in distinct type, and other species specially referred to are in different type. The work cannot fail to be of the greatest service to geologists in all parts of the world, if only it appears punctually. Messrs. Dulau and Co. act as London agents, and the subscription price is thirty shillings.

THE *Transactions* of the Leicester Literary and Philosophical Society (vol. v., part 10, October 1900) contains three excellent pictorial plates of the pre-Cambrian rocks of Charnwood Forest to illustrate an excursion conducted by Prof. W. W. Watts. The reports of other geological excursions are illustrated by remarkably clear maps and sections prepared by Mr. Fox-Strangways. There are also notes on the botany of the Beaumont Leys Sewage Farm, by Mr. A. B. Jackson, and an address to Section E (Zoology) by Mr. F. R. Rowley. Curiously enough, the entomologists form a section by themselves apart from the zoologists, who are urged by Mr. Rowley to take up the neglected groups of "Rhizopoda, Heliozoa, Infusoria, Turbellaria, Oligochæta, Rotifera, Acarina and Polyzoa."

WE have received from the author, Dr. S. Kaestner, a copy of his inaugural address delivered at the Leipzig Academy on the methods of preparation employed in embryological investigation.

THE excellence of the illustrations forms a striking feature of the latest issue (vol. v. No. 2) of *Indian Museum Notes*. Mr. G. B. Buckton describes one new insect injurious to forest rees, and a second to betel; while the other contributors treat of many kinds of insect pests.

TO the January number of the *Entomologist*, Dr. A. G. Butler contributes some highly interesting observations with regard to the seasonal phases of certain South African butterflies. For instance, the form described as *Precis simia* proves to be the wet season phase of *P. antilope*, and *P. trimeni* that of *P. cuama*. Since these phases are not absolutely confined to season, the indiscriminate use of the term "seasonal form" is deprecated.

ACCORDING to the *American Museum Journal* for November, active steps are being taken for the further zoological exploration of Alaska, Mr. A. J. Stone having already started on a preliminary collecting trip. There is, however, a proposal on foot to start an "Arctic Mammal Club," and it is hoped that the 2000 dollars left conditionally by the late Mr. Constable for the exploration of Alaska will be shortly available. The condition is that the amount should be raised to 5000 dollars by other contributors—and in a rich country like the United States there ought to be little difficulty in getting this sum subscribed.

TO the *Proceedings* of the Washington Academy (vol. ii. pp. 661–676), Dr. Merriam contributes a preliminary revision of the red foxes of North America, of which no less than twelve species and races are recognised. The author regards all these forms as specifically distinct from the common fox of Europe and Northern Asia, although he states that the one described as *Vulpes alascensis* is closely related to the latter, which it connects with the more southern American types. To many zoologists this admission would indicate that all the American red foxes are nothing more than local phases of their Old World prototype. In another part of the same journal (pp. 631–649), Mr. G. S. Miller describes a collection of small mammals from Liberia, among which several are new.

WE have received Prof. Herdman's fourteenth annual *Report* of the Liverpool Marine Biological Committee, and their biological station at Port Erin (Isle of Man). The editor observes that although there is nothing remarkable to record in regard to the educational work of the station, yet all lines of research have been continued and all investigations advanced a stage, while several important publications have been issued. Detailed reports of the laboratory, aquarium and dredging operations are given, and seven plates are appended showing the distribution of the marine fauna at the south-western extremity of the Isle of Man and of particular groups of the same in Port Erin Bay. The preparation of these last must have entailed a vast amount of labour on the part of the staff.

AMONG several other papers, vol. xii., part 2, of the *Proceedings* of the Royal Society of Victoria contains a note by Mr. R. H. Walcott relating to the cast of a fossil tree-trunk in basalt. It was found at Footscray, and shown at the Melbourne Exhibition of 1866. Unlike ordinary fossil stems, in which the wood has been replaced, atom by atom, by mineral matter, the whole of the woody matter in the specimen in question was first destroyed, leaving a cavity which was subsequently filled by liquid trap. A necessary condition for the preservation of the tree-form at the time of the entombment of the specimen seems to have been its rapid inclusion in the molten rock, so that the carbonised remains would be inaccessible to the air, and maintain the mould in its proper shape until the trap had cooled sufficiently to prevent it from closing in. A subsequent flow filled the cavity. The author is of opinion that the specimen cannot be a concretion, and, if he is right, it appears to be unique.

MR. J. E. S. MOORE's account of his researches and explorations in Lake Tanganyika and the countries to the northward, published in the January number of the *Geographical Journal*, will be read with interest both by geologists and zoologists, as

well as by the members of the society before which it was presented. After relating the history of the discovery of the remarkable molluscan fauna of the great lake, and pointing out how it differs essentially in its marine *facies* from that of all the other African lakes, the author refers to the Tanganyika jelly-fish, and concludes that the evidence in favour of the marine origin of the "halolimnic" fauna is overwhelming and irresistible. He then discusses the objections that have been raised against his theory on the ground that, according to an opinion advanced years ago by Sir R. Murchison, no part of the interior of Africa has ever been beneath the sea. This opinion was in part based upon the presumed absence of evidence of volcanic activity in Africa south of the equator. The discovery of volcanoes, both active and passive, in this area, as well as of huge lava-flows, discounts the latter part of the objection, while the evidence of the Tanganyika fauna itself is considered to outweigh the other part.

As regards the outlet by which Tanganyika (presumably as far back as Jurassic times) communicated with the ocean, Mr. Moore adduced evidence to show that, instead of being northwards by way of the other great lakes and the Nile valley, this must apparently have taken place by way of the Congo. The author, from the physical features of the country, was led to believe "that the lake had at some former time extended far to the west of its present site, in the neighbourhood of the Lukuga. It is only necessary for such extension to cover some eighty miles to bring it into communication with the great circular basin of the Congo itself." It is true that the evidence against the original northward extension of the lake is mainly of a negative nature, that is to say, the absence of the halolimnic fauna in the northern lakes; but, as Prof. Lankester observed, negative evidence "has its distinct importance and value as much as positive evidence, and we are in a position to say certainly that the marine fauna of which Mr. Moore has so fully established the existence in Tanganyika did not arise from a northward extension of the lake."

PART iv., completing vol. xxi., of the *Transactions* of the Botanical Society of Edinburgh, contains a second article by Mr. C. E. Hall on tree measurements, from which it would appear that in the tropics, as with us, the chief factor in the growth of trees is rain.

A NEW text-book of botany ("Cours de Botanique," published by Dupont, Paris) is announced, by Profs. Bonnier and Leclerc du Sablon, in two vols. (25 fr.), with upwards of 3000 illustrations, mostly drawn from nature. A new departure is claimed, in the item that the description and anatomy of the organs are taken from a certain number of type-species chosen from widely spread plants.

WE have received the Report of the Moss Exchange Club for the years 1899–1900. Associations of this kind are obviously useful in promoting an interest in their particular branch of science, and the study and determination of critical species. Their danger lies in the destruction of rare and local species, and we should have liked to have seen a hint to this effect in the Report. The honorary secretary of the club, to whom communications are to be addressed, is Mr. C. H. Waddell; but we do not find his address in the Report, which is printed at Stroud.

THE volume of *Knowledge* for 1900 contains numerous splendid collotype plates and other illustrations accompanying articles on subjects belonging to most branches of science.

DR. OLIVER LODGE'S presidential address on the controversy concerning Volta's Contact Force, delivered to the Physical Society at the annual general meeting in February last, is published, with other papers, in the December number of the *Proceedings* of the Society.

THE six monthly numbers of the *Geographical Journal*, from July to December 1900, make up volume xvi., which has just been published by the Royal Geographical Society. The volume contains 766 pages, as well as numerous coloured maps, and is full of matter of interest to the student of geography in all its aspects. Among the many important papers are Dr. C. Hose's account of the natives of Borneo, Captain Deasy's "Journeys in Central Asia," Mr. E. S. Grogan's "Through Africa from the Cape to Cairo," Prof. Haddon's "Studies in the Anthropogeography of British New Guinea," Mrs. Ogilvie Gordon's "Origin of Land-Forms through Crust Torsion," Mr. Borchgrevink's description of the *Southern Cross* Antarctic expedition, and Dr. Donaldson Smith's "Expedition between Lake Rudolf and the Nile." Most of the papers are accompanied by reproductions of photographs of the regions or peoples visited.

THE "Guide to the Babylonian and Assyrian Antiquities" in the British Museum, which has just been published, is a marvel of interest and cheapness, the price being only one shilling. The guide provides notes, interpretations, and thirty-four excellent plates, referring to Babylonian and Assyrian antiquities covering a period of about five thousand years, ranging from about B.C. 4500 to A.D. 500. "In them," Dr. Wallis Budge remarks in the preface, "are comprised by far the largest portion of available material for reconstructing the history of Western Asia, inscribed in the cuneiform character." Dr. Budge's numerous contributions to the science of antiquities have had a profound influence upon intellectual progress; and this new guide, though small in comparison with the works which stand as a monument to his vast knowledge of the past, give students an additional reason for being grateful to him. By the publication of the Guide the Trustees of the British Museum have rendered available a mass of information of interest to students and the public alike.

THE publication of a great work on systematic botany has been commenced by Mr. Englemann, of Leipzig (London: Williams and Norgate), under the title "Das Pflanzenreich." The work has been undertaken by Prof. A. Engler, and is to be a complete record of the plant kingdom. Particulars of the plan of the work, two fascicules of which have been received, are given in Messrs. Williams and Norgate's Book Circular for December. Every one of the 280 families is to form a monograph by itself, with a separate and complete index, the larger families each formin g a separate fascicule. Each family begins with the enumeration of the literature, including monographs, which are restricted to genera, provided they deal with general morphological points, while the purely systematic treatises on genera are quoted with the latter. To each family is attached a complete list of its groups, genera and species, with the generic and specific synonyms. The work is amply illustrated by original drawings, with especial reference to the generic and sectional characters of the plants. This gigantic undertaking will, of course, require many years for its completion; but this is guaranteed, to a great extent, by subventions from the Prussian Government and the Imperial Academy of Sciences. The editor is anxious that it should be known that the present "Pflanzenreich" is not a second edition of the "Natürliche Pflanzenfamilien," supplements to which will continue to be published every few years.

THE much-debated question of the existence of an ammonium amalgam would appear to be finally settled in the affirmative as the result of recent researches. The fact that the volumes of ammonia and hydrogen evolved from ammonium amalgam are in the ratio of 2 : 1 has been regarded as evidence in favour of Berzelius' ammonium theory, but the inability of ammonium amalgam to effect the reduction of the heavy metals from their salt solutions, in opposition to potassium and sodium amalgam,

spoke strongly against the theory. The investigation of the electrolytic tension of decomposition of the ammonium salts with a mercury cathode, by Coehn and Dannenberg (*Zeitschrift für anorganische Chemie*, 25, 430), has given results perfectly analogous to those obtained with salts of the alkali metals, a result only explicable on the assumption of the ammonium theory. Experiments carried out under varying conditions to ascertain the possibility of reducing the heavy metals from their solutions, show that the negative results previously obtained are due to the great instability of the ammonium amalgam. By preparing the amalgam electrolytically at low temperatures (0° C.), when it appears to be much more stable and does not exhibit, to any great extent, the spongy appearance peculiar to the amalgam prepared under ordinary conditions, and allowing it to act on cold solutions of copper, cadmium and zinc salts, the formation of the corresponding heavy metal amalgams is easily observed. In the case of the copper, it might be possible to explain the reduction by attributing it to the nascent hydrogen generated in the decomposition of the ammonium amalgam; but this explanation is not possible in the case of the cadmium and zinc salts.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. R. F. Wilson; a Polecat (*Mustela putorius*), British, presented by Mr. Hett; three Painted Snipe (*Rhynchaea capensis*) from India, presented by the Hon. Walter Rothschild, M.P.; a Tawny Owl (*Syrnium aluco*), European, presented by Mr. F. Medcalf; a Deville's Tamarin (*Midas devillii*) from Peru, a —— Conure (*Conurus ocularis*), an Orange-winged Amazon (*Chrysotis amazonica*), a Brazilian Tortoise (*Testudo tabulata*) from South America, three Japanese Pheasants (*Phasianus versicolor*) from Japan, two Pennant's Parrakeets (*Platycercus elegans*), a King Parrot (*Aprosmictus cyanopygius*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

ORIGIN OF TERRESTRIAL MAGNETISM.—The *Observatory* for January contains a translation by Prof. L. A. Bauer, of the U.S. Geodetic Service, of an article in *Ciel et Terre*, December 16, 1900, containing the results obtained by Dr. Schmidt from an important harmonic analysis of the permanent magnetic field of the earth. This work has been practically an amplification of Gauss' "Théorie générale du magnétisme terrestre."

In Schmidt's analysis he does not assume the existence of an interior potential function governing the entire magnetic force; but adjusting separately each of the three rectangular components, obtains three expressions in place of the one determined by Gauss; moreover, the computations have been carried to the terms of sixth order instead of the fourth. He concludes that the magnetic force of the earth consists of three parts:—

(1) *The greatest part*, attributed to causes situated in the terrestrial crust, and having a potential.

(2) *The smallest part* (about one-fortieth the whole), due to causes exterior to the crust, and also possessing a potential.

(3) A part, somewhat greater than (2), not represented by a potential, and therefore indicating the existence of *vertical* terrestrial electric currents.

Dr. Schmidt has also made careful examinations of the records of magnetic storms. In that of February 28, 1896, which was observed at fifteen observatories, and lasted from 6-7 o'clock, he finds that the directions of disturbance vary considerably, at times converging to a point, at others radiating from a point; while at certain periods of comparative calm the lines of force were practically parallel, suggesting a distant centre of force. Taking these facts in consideration with the vertical component disturbances, he concludes that the causes producing terrestrial magnetic storms are for the most part exterior to the surface of the earth.

OPPOSITION OF MARS IN 1888.—Signor G. V. Schiaparelli has recently published a sixth volume of observations of Mars, containing the discussion of his determinations on the topography and constitution of the planet during the opposition of 1888, made with the 18-inch Merz refractor at the Milan Observatory. After preliminary notes of instrumental details and tables showing varying size of the disc, atmospheric quality, &c., about eighty pages are devoted to the detailed description of the aspects of the many markings recognised during the period, very many comparisons with the work of other observers being included; the remainder of the volume is occupied with the discussion of observations bearing on the constitution of the surface, giving detailed measures and descriptions of the varying polar caps, and a comparative analysis of the gemination of the principal "*canali*." Reproductions of drawings of the surface markings on successive dates are included, and two polar charts showing the whole of the observed phenomena in their relative longitudes.

DOUBLE STAR MEASURES.—In the *Astronomische Nachrichten* (Bd. 154, No. 3679) Mr. J. Comas Sola gives a series of measures of seventy-five double stars observed at Barcelona.

SCIENTIFIC DEVELOPMENTS OF BIOLOGY AND MEDICINE.

AN interesting monograph is just to hand in the shape of a lecture, delivered by Dr. Oscar Hertwig upon the occasion of the congress of German naturalists at Aix la Chapelle (Aachen). The subject is the development of biology in the nineteenth century. Many interesting points, forming landmarks in the progress of biological science, are discussed by the lecturer. The microscope, from the inestimable service it has rendered to morphology, must rank high in the discoveries of the century. Before morphological method had been enriched by it, the cellular hypothesis, which is the foundation stone of all biology, was impossible. Dr. Hertwig accentuates the fact that progress consists, not only in adding facts to our treasury of knowledge, but also in stamping out error, and that some of the biological energy of the nineteenth century has been consumed in annihilating the doctrine of spontaneous generation; it was, indeed, only Pasteur's researches that established irrefutably the dictum *Omne vivum e vivo*, and much later still did the corollary of this, namely *Omnis cellula e cellula*, firmly plant itself upon biology, never to be uprooted.

A further factor of transcendental importance in the progress of biology during the nineteenth century was the birth and growth of the study of embryology. Its chief result was the theory of evolution and the accompanying doctrines of natural selection and the survival of the fittest. The lecturer enters fully into the literature of this subject, which has moved the biological world perhaps more than any preceding one. The concluding part of the discourse is devoted to the progress made in that department of biology which we know as physiology. The attempt in this direction during the latter part of the century has been to reduce, by means of physico-chemical technique, biological phenomena to physico-chemical law. This attempt, although it has given us an enormous insight into the processes of life and has enabled us to formulate laws of the highest abstract and utilitarian value, has been, in its absolute sense, unsuccessful. It is doubtful if chemical and physical law can ever explain fully the phenomena of life, and while physiological chemistry and physics have destroyed the old vitalism, we are, to some extent, compelled to take refuge in a new one. From the practical standpoint, great progress has been made in the development of pharmacology and experimental pathology. The former, going hand in hand, as it ever must, with the practical treatment of disease, has not only thrown light upon many problems of pathology and physiology, but has greatly increased the possibilities of therapeutics, and given distinct hope for the future in this direction. Under experimental pathology serum therapy is included, and the immense field for research this has opened up.

An address delivered by Dr. Naunyn, of Strassburg, at the same congress, is of considerable interest. He chose for his subject the development of medicine, hygiene and bacteriology during the nineteenth century. To show the condition of medical thought at the beginning of the century, he quotes from the work of Prof. Kieser, of Jena, in 1812. At that time the exanthemata were regarded as necessary stages in the growth of mankind, and as essential to his perfect development, just as the pupa stage is essential to the butterfly. The scientific development of medicine, according to Prof. Naunyn, took its first real

impetus from the work of Johannes Müller. His text-book of physiology was a book which focussed the work of preceding generations for the purpose of pointing out the direction which the work of succeeding generations should take. This, and the subsequent discoveries of Laennec, formed the first scientific basis of medicine. The next step forward was the founding and development of morbid anatomy, going hand in hand with clinical medicine; in fact, any further progress of the latter without the former was impossible. In this respect the Vienna School, as exemplified by the clinician Skoda, working in connection with the pathologist Rokitansky, did giant service. Subsequently the researches of Pasteur, upon fermentation, and the antiseptic work of Lister form striking monuments in the century's progress. The latter was of value, according to the author, in a somewhat unanticipated direction, in that it rendered explorative operations possible, and thus enabled clinicians to observe disease in a stage short of that which it presented at the post-mortem examination. Last, but not least, Prof. Naunyn refers to the rise and the progress made by pharmacology, and points out the brilliant therapeutical results which have issued from pharmacological research.

THE DISTRIBUTION OF VERTEBRATE ANIMALS IN INDIA, CEYLON AND BURMA.[1]

THE completion of the seven volumes containing descriptions of all the vertebrata, in the "Fauna of British India," affords an opportunity of reviewing generally the distribution of terrestrial vertebrate animals throughout the British possessions in India, Ceylon and Burma.

For the study of zoological distribution there are few, if any, regions on the earth's surface that exceed British India and its dependencies in interest. The area is about 1,800,000 square miles, and although the vertebrate fauna is by no means thoroughly explored, it is well known throughout the greater part of the area and fairly known throughout the whole, better, probably, than in any other tropical and sub-tropical tract of approximately equal extent. The variety of climate is remarkable; within the area are included the almost rainless deserts of Sind and the locality on the Khási Hills, distinguished by the heaviest rainfall known, the cold, arid plateau of the Upper Indus drainage, and the damp tropical forests of Malabar and Tenasserim. The country is bounded on the north by the highest mountain range in the world and on the south by an ocean extending to the Antarctic regions. Another element of interest lies in the fact that the peninsula of India is a land of great geological antiquity, there being no evidence that it has ever been submerged, although the greater part of the Himalayas and Burma have at times been beneath the sea.

The plan adopted for the study has been to divide the whole country into nineteen tracts, distinguished by physical characters —such as rainfall, temperature, presence or absence of forests, and prevalence of hilly ground, and to construct tables showing the distribution of each genus of land or fresh-water vertebrate in the tracts. Genera have been selected for consideration because families and sub-families are too few in number and too wide in range, whilst species are too numerous and too unequal in importance. In the demarcation of regions and sub-regions, terrestrial mammalia are regarded as of primary importance.

The tracts are the following:—

A. *Indo-Gangetic Plain.*

1. Punjab, Sind, Baluchistan and Western Rajputana.
2. Gangetic Plain from Delhi to Rajmahal.
3. Bengal from Rajmahal to the Assam Hills.

B. *Indian Peninsula.*

4. Rajputana and Central India as far south as the Nerbudda.
5. Deccan from the Nerbudda to about 16° N. lat. and from the Western Ghats to long. 80° E.
6. Behar, Orissa, &c., from the Gangetic Plain to the Kistna.
7. Carnatic and Madras, south of 5 and 6, and east of the Western Ghats.
8. Malabar Coast, Concan and Western Ghats or Sahyádri range from the Tapti River to Cape Comorin.

[1] Abridged from a paper read at the Royal Society, on December 13, 1900, by Dr. W. T. Blanford, F.R.S.

C. *Ceylon.*

9. Northern and Eastern Ceylon.
10. Hill Ceylon, the Central, Western and Southern Provinces.

D. *Himalayas.*

11. Western Tibet and the Himalayas above forest.
12. Western Himalayas from Hazára to the western frontier of Nepal.
13. Eastern Himalayas, Nepal, Sikhim, Bhutan, &c.

E. *Assam and Burma.*

14. Assam and the hill ranges to the south with Manipur and Arrakan.
15. Upper Burma, north of about 19° N. lat.
16. Pegu from the Arrakan Yoma to the hill ranges east of the Sittang.
17. Tenasserim as far south as the neighbourhood of Mergui.
18. South Tenasserim, south of about 13° N. lat.
19. Andaman and Nicobar Islands.

A review of the fauna of these tracts leads to the following conclusions:—

(1) The Punjab tract differs greatly in its fauna from the Indian Peninsula and from all countries to the eastward, so greatly that it cannot be regarded as part of the Indo-Malay or Oriental region. Of terrestrial mammals, bats excluded, 30 genera are met with, of which 8 or 26½ per cent. are not Indian, whilst of reptiles (omitting crocodiles and chelonians) 46 genera occur, and of these 20 or 43½ per cent. are unknown further east. Of the corresponding orders of mammalia 46, and of reptiles 80 genera occur in the Peninsula, and 24 or 52 per cent. of the former and 57 or 64 per cent. of the latter are not found in the Punjab tract. All the genera met with in the Punjab tract and wanting further east are either Holarctic forms or peculiar, but with Holarctic affinities.

The Punjab, Sind and Western Rajputana are in fact the eastern extremity of the area known as the Eremian or Tyrrhenian or Mediterranean sub-region, generally regarded as part of the Holarctic region, but by some classed as a region by itself corresponding to the Sonoran in North America.

(2) The Himalayas above the forests and such portions of Tibet as come within Indian political limits (Gilgit, Ladák, Zanskar, &c.) belong to the Tibetan sub-region of the Holarctic region. Of twenty-five mammalian genera hitherto recorded from No. 11 (the Tibetan) tract, 11 or 44 per cent. are not found in the Indo-Malay region. That Tibet forms a distinct mammalian sub-region has already been shown in other papers.

(3) India proper from the base of the Himalayas to Cape Comorin, and from the Arabian Sea and the eastern boundary of the Punjab tract to the Bay of Bengal and the hills forming the eastern limit of the Gangetic alluvium, should, with the addition of the island of Ceylon, be regarded as a single sub-region, and may be conveniently entitled the Cisgangetic sub-region. The forests of the Sahyádri range and of the western, or Concan and Malabar, coast and the hill area of Southern Ceylon have a far richer fauna than the remaining area, but are not sufficiently distinct to require sub-regional separation.

The Cisgangetic sub-region is distinguished from the Transgangetic by the presence amongst mammals of Hyænidæ, Erinaceinæ, Gerbillinæ, of three peculiar genera of antelopes and of some other types; amongst birds by the occurrence of Pterocletes (sand grouse), Phœnicopteri (flamingoes), Otididæ (bustards) and Cursoriinæ; amongst reptiles by the possession of the families Eublepharidæ, Chamæleontidæ and Uropeltidæ, together with many peculiar Geckonidæ, Agamidæ, Lacertidæ and Scincidæ, and amongst batrachians by about one-half of the genera found in each sub-region being absent in the other. The difference between the reptiles and batrachians by itself would justify the classification of the two areas as distinct regions, a view adopted by several writers.

The difference between the Cisgangetic vertebrate fauna and that inhabiting the rest of the Indo-Malay or Oriental region is partly due to the absence in the former of numerous Eastern types, and partly to the presence of two constituents besides the Oriental genera, which, especially in forest, form a majority of the animals present. One of these two constituents consists of mammals, birds and reptiles having a distinct relationship with Ethiopian and Holarctic genera, and with the Pliocene

Siwalik fauna. This constituent of the Cisgangetic fauna it is proposed to distinguish by the term Aryan. The other constituent is composed of reptiles and batrachians and may be termed the Dravidian element. The latter is well developed in the south of the Peninsula and especially along the south-west or Malabar coast, and in Ceylon, but it gradually disappears to the northward, its northern limit, so far as is known at present, not extending to the 20th parallel of north latitude. It is probable that this is the oldest part of the Cisgangetic fauna, and it may have inhabited the country since India was connected by land with Madagascar and South Africa, across what is now the Indian Ocean, in Mesozoic and early Cenozoic times. The other two elements, the Indo-Malay or Oriental and the Aryan, are probably later immigrants, and its wider diffusion may indicate that the Indo-Malay element has inhabited the Indian Peninsula longer than the Aryan has. There appears some reason for regarding the Indo-Malay portion of the fauna as dating in India from Miocene times and the Aryan from Pliocene, whilst in the Pleistocene epoch the proportion of Aryan to Indo-Malay types of mammals in India, as shown by the fossil faunas of the Nerbudda and the Karnul caves, was much larger than at the present day.

There are some other peculiarities of the Indian Peninsula fauna to which attention may be called. One of these is the presence of genera and sometimes of species which are found on both sides of the Bay of Bengal, but not in the Himalayas or Northern India. A good example is afforded by the genus *Tragulus*, of which one species inhabits Ceylon and India south of about 22° N. lat., whilst two others are found in Southern Tenasserim and the Malay Peninsula. In Pliocene times the genus inhabited Northern India. Another instance is the lizard *Liolepis guttatus*, found in Burma and Arrakan and also in South Canara on the west coast of India. Examples amongst reptiles are rather numerous. Moreover, whilst there are numerous alliances between the animals of Peninsular India and those of Africa, there are also some curious connections between India and Tropical America, but these are chiefly amongst invertebrates. Some, however, are found in reptiles. It is probable that such Indo-American connections are vestiges of older life than the Indo-African. They are, of course, generally speaking, instances of animal groups once more widely distributed, but now only preserved in a few favourable tropical localities.

(4) The forest area of the Himalayas belongs to the same sub-region as Assam, Burma (except South Tenasserim), Southern China, Tonquin, Siam and Cambodia, and to this sub-region the term Transgangetic may be applied. It is distinguished from the Cisgangetic sub-region by the absence of the animals already specified as characteristic of that area and by the presence of the following, which are wanting in the Indian Peninsula—Mammals: the families Simiidæ, Procyonidæ, Talpidæ and Spalacidæ, and the sub-family Gymnurinæ, besides numerous genera such as *Prionodon*, *Helictis*, *Arctonyx*, *Atherura*, *Nemorhaedus* and *Cemas*. Birds: the families Eurylæmidæ, Indicatoridæ and Heliornithidæ, the sub-family Paradoxornithinæ. Reptiles: Platysternidæ and Anguidæ. Batrachians: Discophidæ, Hylidæ, Pelobatidæ and Salamandridæ.

The relations of the Himalayan fauna to that of Assam and Burma on the one hand, and to that inhabiting the Peninsula of India on the other, may be illustrated by the mammals with bats omitted. Of forty-one genera occurring in the Himalayas, three are not found in the hills south of Assam or in Burma, whilst sixteen are wanting in the Cisgangetic region. It should be remembered that a large number of the genera are widespread forms. As the result is not in agreement with the views of some who have written on the subject, the relations of species have been examined. It results that eighty-one species of mammalia, belonging to the orders Primates, Carnivora, Insectivora, Rodentia and Ungulata, are recorded from the forest regions of the Himalayas. Of these two are doubtful, twenty-two are not known to occur south of the Himalayan range in India or Burma, twenty-one are wide ranging forms and are found in both Burma and the Indian Peninsula, one only (*Hystrix leucura*) is common to the Himalayan forests and the Indian Peninsula, but does not range east of the Bay of Bengal, whilst thirty-five are found in the countries east of the Bay of Bengal but not in the Peninsula south of the Ganges. Of the thirty-five, eight only range as far as the hills south of the Assam Valley, sixteen to Burma proper, and eleven to the Malay Peninsula and Archipelago. Of the twenty-two species not ranging south of the Himalayas a large majority are either Holarctic species or belong to Holarctic genera.

The fauna of the Himalayan forest area is partly Holarctic, partly Indo-Malay. It is remarkably poor, when compared with the Cisgangetic and Burmese faunas, in reptiles and batrachians. It also contains but few peculiar genera of mammals and birds, and almost all the peculiar types that do occur have Holarctic affinities. The Indo-Malay element in the fauna is very richly represented in the Eastern Himalayas, and gradually diminishes to the westward until in Kashmir and farther west it ceases to be the principal constituent. These facts are consistent with the theory that the Indo-Malay constituent of the Himalayan fauna, or the greater portion of it, has migrated into the mountains from the eastward at a comparatively recent period. It is an important fact that this migration appears to have been from Assam and not from the Peninsula of India.

(5) Southern Tenasserim agrees best in its vertebrata with the Malay Peninsula, and should be included in the Malayan sub-region of the Indo-Malay region.

There are several points left which require explanation. There is the much greater richness of the Oriental constituent in the Cisgangetic fauna to the southward in Malabar and Ceylon, although this is far away from the main Oriental area, and the ocurrence also in the southern part of the Peninsula of various mammalian, reptilian and batrachian genera, such as *Loris*, *Tragulus*, *Draco*, *Liolepis* and *Ixulus*, which are represented in Burma and the Malay countries but not in the Himalayas or Northern India. In connection with this the limitation of the Dravidian element to the south of India should also be remembered. Then there is the occurrence of certain Himalayan species on the mountains of Southern India and Burma and even farther south, but not in the intervening area. There is also the predominance of the Western, or what I have proposed to call the Aryan, element in the Pleistocene fauna of the Nerbudda Valley, and of Karnul in the north of the Carnatic tract. Lastly, we have to account for the apparently recent immigration of Oriental types into the Himalayas.

Whilst it is quite possible that other explanations may be found, it is evident that all these peculiarities of the Indian fauna may have been due to the Glacial epoch. The great terminal moraines occurring at about 7000 feet in Sikhim and the occurrence of similar moraines and other indications of ice action at even lower levels in the Western Himalayas clearly show that the temperature of the mountain range must have been much lower than at the present day, when no glacier in Sikhim is known to descend below about 14,000 feet.

During the coldest portion of the Glacial epoch, a large part of the higher mountains must have been covered by snow and ice, and the tropical Indo-Malay fauna which had occupied the range, and which may have resembled that of the Indian Peninsula more than is the case at present, must have been driven to the base of the mountains or exterminated. The Holarctic forms apparently survived in larger numbers. The Assam Valley and the hill ranges to the southward would afford in damp, sheltered, forest-clad valleys and hill slopes a warmer refuge for the Oriental fauna than the open plains of Northern India and the much drier hills of the country south of the Gangetic plain. The Oriental types of the Peninsula generally must have been driven southwards, and some of them, such as *Loris* and *Tragulus*, which must originally have been in touch with their Burmese representatives, have never returned. It was probably during this cold period that the ossiferous Nerbudda beds and the deposits in the Karnul caves were accumulated. The tropical damp-loving Dravidian fauna, if it inhabited Northern India, must have been driven out of the country. Unless the temperature of India and Burma generally underwent a considerable diminution, it is not easy to understand how plants and animals of temperate Himalayan types succeeded in reaching the hills of Southern India and Ceylon, as well as those of Burma and the Malay Peninsula.

When the whole country became warmer again after the cold epoch had passed away, the Transgangetic fauna appears to have poured into the Himalayas from the eastward. At the present day the comparatively narrow Brahmaputra plain in Assam is far more extensively forest-clad, especially to the eastward, than is the much broader Gangetic plain of Northern India, and if, as is probable, the same difference between the two areas existed at the close of the Glacial epoch, it is easy to see how much greater the facilities for the migration of a forest-haunting fauna

must have been across the Brahmaputra Valley than over the great plain of the Ganges. This difference alone would give the Transgangetic fauna of Burma an advantage over the Cisgangetic fauna in a race for the vacant Himalayas, even if the latter had not been driven farther to the southward than the former, as it probably was during the Glacial epoch.

The theory, however, is only put forward as a possible explanation of some remarkable features in the distribution of Indian vertebrates. At the same time it does serve to account for several anomalies of which some solution is necessary. If thus accepted, it will add to the evidence, now considerable, in favour of the Glacial epoch having affected the whole world, and not having been a partial phenomenon induced by special conditions, such as local elevation.

SCIENCE TEACHERS IN CONFERENCE.

FOR the third time the Technical Education Board of the London County Council has arranged and held a conference of teachers of science from all parts of the kingdom. Since their inauguration, these annual meetings have steadily grown in popularity. At the first conference, in 1899, there was an attendance of eighty persons, in 1900 the number had grown to 200, while at the meetings held last week the attendance reached the total of 350. These satisfactory results are largely due to the efforts of Mr. C. A. Buckmaster, of the Board of Education, and Dr. Kimmins, the Inspector to the Technical Education Board, who have steadily worked during the three years in encouraging lecturers, demonstrators and inspectors to meet together for the discussion of methods of teaching different branches of science. The addresses and papers brought before the conference at the South-Western Polytechnic, Chelsea, on January 10 and 11, dealt with subjects of great importance in an interesting and instructive manner; but the discussions were not entirely satisfactory. It is useless to expect teachers to contribute anything valuable to a discussion at a moment's notice. It should be possible at future meetings to obviate in a large measure the desultory speeches on more or less general topics which this year followed the addresses and papers. If half a dozen well-known, practical teachers were given an abstract of the paper before the meeting, they would be able, with a few days' preparation, to place succinctly before the meeting the results of their own practice, and besides putting the discussion on right lines, they would lead other teachers with experience of the matter in hand to help forward a complete presentation of the subject.

One more preliminary remark is necessary. Too much was attempted at separate meetings, at some of which as many as three papers were read and put down to be discussed in two hours. The consequences were unfortunate. To name one instance only: at the third meeting, not only was Prof. Armstrong unable to deliver the whole of the paper he had prepared on the teaching of domestic science, but though the discussion was continued some fifteen minutes after the proper time, he was not called upon to reply to the points raised by different speakers. It is to be hoped that next year fewer subjects will be taken up at each meeting, and more pains taken to secure an ample discussion, rigidly kept to the matter in hand.

INSTRUMENT MAKING.

At the first meeting of the conference, Mr. T. A. Organ, the Chairman of the Technical Education Committee of the London County Council, presided. In his introductory remarks the Chairman insisted on the need there is still for improved science teaching in our schools, and directed attention to a growing danger of doing too much for students. What has been called in America "peptonised" education seems to be on the increase, and is much to be deprecated. Addresses were given on "Instrument-making for schools and technical classes," by Mr. W. Hibbert, of Regent Street Polytechnic; and on the "Co-ordination of workshop and laboratory instruction," by Mr. T. P. Nunn, of William Ellis's School, and Mr. A. G. Hubbard, of Raine's School. During the course of his remarks, Mr. Hibbert described, with the aid of lantern slides, a large number of simple pieces of apparatus for use in the teaching of electricity and magnetism, amongst which his magnetometer, which can be easily converted into an astatic galvanometer, his electroscope, capable of detecting one-tenth the potential difference recognisable by the ordinary forms of instrument, and his standard magnets are particularly worth mention. The remaining addresses described successful attempts to make the work of the manual instruction teacher assist the practical study of physics. In the subsequent discussion, Dr. Gladstone, F.R.S., referred to the efforts he had made on the London School Board in the direction of supplying the teachers of the schools of the Board with simple, inexpensive apparatus which would satisfactorily demonstrate the elementary principles of physics and chemistry.

THE FITTING UP OF LABORATORIES.

Sir W. de W. Abney, K.C.B., F.R.S., took the chair at the second meeting, and lectures were given by Messrs. J. B. Coleman, A. Schwartz and W. W. Pullen, describing the fittings and apparatus of the chemical, physical and mechanical laboratories, of which they respectively have charge at the South-Western Polytechnic. After the addresses, which were profusely illustrated with lantern slides, a discussion was opened by Prof. Armstrong, F.R.S. Referring to the provision which Mr. Coleman has made for the proper writing of notes in the laboratory itself at the time the practical exercise in science is actually performed, Prof. Armstrong urged that one of the most valuable results from intelligent science teaching is the excellent progress the pupil makes in his ability to express himself in a literary manner when called upon to systematically describe the work he has performed. He also urged that it is a great mistake to suppose that palatial establishments, such as those described by the lecturers, are really necessary for teaching science to boys and girls. Pretentious "drawing-room" laboratories are by no means desirable; what is wanted is not so much a laboratory as a workshop, which need be little more than a shed, such as a contractor about to put up a large building erects for the use of his workmen. Students who work in the sumptuously-fitted places now provided are not suitably trained for the work of life; nobody in commercial undertakings gets a place anything like as good as a school laboratory in which to do his professional work. The thing of importance is the spirit with which the work is undertaken, not the number of appliances at the disposal of the teacher and pupil.

In acknowledging a vote of thanks, and at the same time summarising the papers and discussion, Sir W. Abney explained that his experience in connection with the Board of Education at South Kensington has shown him what a great deal can be done with very simple apparatus. He had, he said, again and again met, in different parts of the country, teachers using the simple pieces of physical apparatus they had made in the laboratories of the Royal College of Science during the courses of instruction arranged for them there during the summer vacation. The teacher of science who has learnt how to make and devise these simple pieces of apparatus can, with the aid of his pupils, easily turn out apparatus quite suitable for satisfactorily demonstrating the important laws of chemical and physical science.

DOMESTIC SCIENCE.

The third meeting, over which Mr. Bousfield, Chairman of the Girls' Public Day School, presided, was devoted to a consideration of the science teaching in girls' schools, especially as to what form of instruction in domestic science is desirable. The first paper was read by Miss Aitken, of the North London Collegiate School, who gave it as her opinion that the best practical teaching in science for girls is given in the now well-known schools of science held in connection with the South Kensington branch of the Board of Education. The generality of girls' schools are not, Miss Aitken finds, properly provided with necessary and suitable accommodation for the pupils to themselves make experiments with simple apparatus, the classes in science are too large, and the amount of time placed at the disposal of the science mistress is ludicrously inadequate.

Prof. Armstrong, in a paper on the teaching of domestic science, laid it down that the object of their instruction should be the formation of habits, not the accumulation of knowledge. Elementary work, in what Prof. Armstrong prefers to call *νους* or "knowingness" rather than science, should throughout aim at developing and strengthening a young pupil's mother wit. Anything may be taught and in any way, provided it leads to the cultivation of *νους*. All teaching in domestic science must be guided by considerations of this kind, and the fundamental subjects of a suitable course will be measuring work, which will not be unduly prolonged, but give place at an early stage to continued exercises with the balance; the study of the

properties of water will follow, after which the effects of heat can with advantage be taken up, and so prepare the way for the final stage of the preliminary course—namely, the study of the air, more particularly in relation to the part it plays in the combustion of food and fuel. But throughout the course constant work with the balance must take a prominent part. The balance inculcates thrift and morality generally, and weighing should be so constantly resorted to that it becomes an absolute habit. If Rudyard Kipling could but be persuaded to write a song with the refrain "Weigh, weigh, weigh," which could be hummed by girls during their lessons in practical work in science, as well as sung on State occasions, he would be doing education a great service.

Prof. Tilden, F.R.S., opened a discussion and referred to the neglect of book-keeping in household management, and directed attention to the fact that a sound education must take notice of other subjects than science.

PSYCHOLOGY AND SCIENCE TEACHING.

Sir Henry Roscoe, F.R.S., took the chair at the concluding meeting, at which Prof. Earl Barnes gave an address on nature teaching for young children, and Principal Lloyd Morgan, F.R.S., lectured on psychology and science teaching. Prof. Morgan said a lecturer in psychology had been defined thus by a pupil—"He tells us what every one knows in language which nobody can understand," but he hoped to avoid the dangers mentioned in the definition. It is easier to indicate what is not education than to give a satisfactory account of what it is: "when one fellow talks about what he doesn't understand to other fellows who don't understand him, that's *not* education." The teacher ignorant of psychology is somewhat of a quack, the honest and earnest instructor must have some practical knowledge of mental processes. In fact, all science teachers ought to take a course in psychology as part of their recognised curriculum in training for their life-work. But such work in psychology should have an experimental basis; the professor and his students must participate in an investigation together. Prof. Morgan then described, with a series of practical demonstrations, the research he was assisting his own students to carry out. In all such practical work it is borne in mind that the first stage in a normal course of mental sequence is that of observation presenting facts which demand explanation; the second that of discovery; and the third that of testing and applying the principles. A discussion followed in which the chairman and Dr. Gladstone took part.

A collection of home-made apparatus for science teaching in schools was on view during the days of the conference, and the chemical, physical and mechanical laboratories of the Polytechnic were open for inspection. A. T. SIMMONS.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Sedgwick prize in geology has been awarded to Mr. F. R. C. Reed, M.A., of Trinity College.

At Peterhouse the following entrance scholarships in Natural Science have been awarded: Blackie, Tonbridge School, 50*l.*; King, City of London School, 40*l.*

THE University of Cincinnati was re-organised in the latter part of last year, and an account of the changes, with photographs and short biographical sketches of the Faculty as now constituted, is given in *Chic.* The most distinctive change is the introduction of the elective system, which permits the student to follow the course of study which best suits his needs for the profession or business he intends to follow after leaving the University. A college of commerce and administration is in contemplation, which will have for its object practical instruction in methods of business in conformity with modern demands. The endowment fund of the University, through the bequests of a number of generous benefactors, amounts to the substantial sum of 3,357,308 dollars, or more than 700,000*l.* The president of the University is Dr. H. Ayres, formerly professor of biology in the University of Missouri.

Literature remarks:—The close of the term for the Christmas vacation has shown the interest of the American millionaire in the advancement of learning. Mr. J. D. Rockefeller gives 300,000*l.* to the University of Chicago and 3000*l.* to the Vermont Academy. Wellesley College, Mass., receives 20,000*l.* from various donors, and Ripon College, Wisconsin, comes into possession of a handsome building for scientific study, the gift of Mr. O. H. Ingram. The Universities have, on the whole, done well by the millionaires. Here is a summary of the largest endowments and their givers:—

Chicago University	J. D. Rockefeller	$9,133,874	£1,902,848
Gerard College	Stephen Gerard	7,000,000	1,458,333
Pratt Institute	Charles Pratt	3,600,000	750,000
Johns Hopkins Univ.	Johns Hopkins	3,000,000	625,000
Drexel Institute	A. J. Drexel	3,000,000	625,000
L. Stanford University	Leland Stanford, jun.	2,500,000	520,833
Cornell University	Ezra Cornell	1,500,000	312,500
Vanderbilt University	The Vanderbilts	1,100,000	229,166
Columbia University	Seth Low	1,000,000	208,333

But there are millionaires outside of America, and the list may at any rate be taken as an example *pour encourager les autres.*

SCIENTIFIC SERIALS.

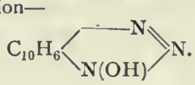
American Journal of Science, January.—The stereographic projection and its possibilities, from a graphical standpoint, by S. L. Penfield. Two stereographic protractors devised by the author are described, and detailed instructions given for their use. These protractors are especially adapted to crystallographic problems, but this branch of the subject is postponed for special consideration in a further communication.—On the mode of occurrence of topaz near Ouro Preto, Brazil, by Orville A. Derby. The yellow Brazilian topaz of the Ouro Preto district was stated by Eschwege to occur in association with talcose or chlorite schist, and this was confirmed to some extent by Mawe, Spix and Martius. This view was contested by Gorceix, who found that the unctuous schists of this region are essentially micaceous. The results of the author's researches in this district show that the occurrence of the topaz here does not differ so materially from the other known ones as has hitherto been supposed. The mineral does not occur in an essentially magnesian rock, nor is its matrix of presumably sedimentary rather than of eruptive origin.—A chemical study of the glaucophane schists, by Henry S. Washington. Analyses of glaucophanes from Syra, Oregon, Croatia, Anglesey, California, Japan and Piedmont, sixteen analyses in all. The glaucophane schists are found to belong to two classes. The larger one is basic, and consists chiefly of glaucophane and epidote, and scarcely differs in chemical composition from the amphibolites and eclogites. A smaller, but widely spread group, is acid in composition, and these are composed largely of quartz and glaucophane.—On the nature of the metallic veins of the Farmington meteorite, by O. C. Farrington. The question of the origin of the metallic veins in a meteorite is of interest as throwing light on the origin, terrestrial or pre-terrestrial, of the meteorite. Preston's views on the veins in the Farmington meteorite are discussed and shown to be improbable.—*Erigenia bulbosa*, by Theo. Holm. An examination of the question as to whether the globular underground part of this plant is a true tuber or a tuberous root. After some trouble, specimens of the plant were obtained in the seedling stage, and the bulb was found to be a tuberous root.—New species of Merycochœrus, in Montana, by Earl Douglass. This species, described as *M. altiramus*, found in the Madison Lake beds of the Loup Fork epoch, is represented by a right mandibular ramus which only lacks the posterior border and some other small fragments. The paper is illustrated by five diagrams of the dentition, accompanied by careful measurements.

Bulletin of the American Mathematical Society, December, 1900.—Prof. F. N. Cole gives an account of, with abstracts of the papers read at, the October meeting of the Society. As these papers will be printed *in extenso* in the *Bulletin*, or in the *Transactions*, we omit the consideration of them here. Prof. M. Bôcher devotes a page to a note on linear dependence of functions of one variable. Report on the groups of an infinite order, by Dr. G. A. Miller, was read before Section A of the American Society for the Advancement of Science, which met at New York in June last. This is a useful *résumé* of recent work done upon the theory of groups, with copious references to original memoirs. Two reviews follow, viz., of Ewing's "The Strength of Materials," by Dr. C. Chree, and of the "Anwendung der Differential- und Integralrechnung auf Geometrie" of Dr. G. Scheffers (Bd. i. "Einführung in die Theorie der Curven in der Ebene und im Raum"), by Prof. J. M. Page. Notes and new publications close the number.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, December 13, 1900.—Prof. Thorpe, President, in the chair.—Prof. H. A. Miers delivered the Rammelsberg Memorial Lecture.—December 20, 1900, Prof. Thorpe, President, in the chair.—On the union of hydrogen and chlorine, by J. W. Mellor. The mixture of hydrogen and chlorine obtained by the electrolysis of hydrochloric acid always contains measurable quantities of oxygen. A slight contraction occurs on mixing gaseous chlorine and hydrogen chloride.—The nitration of the three tolueneazophenols, by J. T. Hewitt and J. H. Lindfield. The three tolueneazophenols are nitrated by warm dilute nitric acid, and in each case the nitro-group enters the phenol ring in the ortho-position relatively to the hydroxyl group.—The bromination of the ortho-oxyazo-compounds and its bearing on their constitution, by J. T. Hewitt and H. A. Phillips. Ortho-oxyazo-compounds appear to react towards bromine as true oxyazo-compounds, and not as orthoquinone-hydrazones.—On the use of pyridine for molecular weight determinations by the ebullioscopic method, by W. R. Innes. Molecular weight determinations show that pyridine does not favour the association of dissolved substances; its molecular rise in boiling point is 29·5.—The influence of the methyl group on ring formation, by A. W. Gilbody and C. H. G. Sprankling. The authors have determined the stability of phenylsuccinimide and its alkyl derivatives in alcoholic solution. It is found that the stability of the succinimide ring is decreased by introducing methyl groups into the fatty ring, whilst Miolati has found that the introduction of fatty groups into the aromatic ring increases the stability.—Experiments on the production of optically active compounds from inactive substances, by F. S. Kipping.—A lecture table experiment for the preparation of nitric oxide, by A. Senier.—The action of ethylene dibromide on xylidine and pseudocumidine, by A. Senier and W. Goodwin.—The action of phenylcarbimide on diphenyl-, dialphyl- and dinaphthyl-diamines, by A. Senier and W. Goodwin.—Note on the action of nitrous acid on β-nitroso-α-naphthylamine, by A. Harden and J. Okell. On treating β-nitroso-α-naphthylamine in alcoholic solution with potassium nitrite and hydrochloric acid, a salt of the composition $C_{10}H_6O_2N_3K$ is obtained; this and the corresponding sodium salt, when treated with stannous chloride and acid, yield a substance which is probably an imidazole of the following constitution—



—1:2:4-Metaxylidine-6-sulphonic acid, by H. E. Armstrong and L. P. Wilson. In accordance with the views previously published by Armstrong, it is found that although excess of fuming sulphuric acid converts 1:2:4-metaxylidine into the 5-sulphonic acid, the 6-sulphonic acid is readily obtainable by heating the sulphate of the base.—The preparation of acetylchloraminobenzene and related compounds, by F. D. Chattaway and K. J. P. Orton.

Geological Society, December 19, 1900.—J. J. H. Teall, F.R.S., President, in the chair.—On the igneous rocks associated with the Cambrian beds of the Malvern Hills, by Prof. T. T. Groom. The Cambrian beds of the Southern Malverns are associated with a series of igneous rocks which have commonly been regarded as volcanic, but are probably all intrusive. They consist of a series of bosses, dykes, sills and small laccolites intruded into the Upper Cambrian Shales and into the Hollybush Sandstone. The dykes appear to be confined to the sandstones, the sills and laccolites chiefly to the shales, while the bosses are found in both. All the rocks have a local stamp, but are probably most nearly related to the camptonitic rocks of the Central English Midlands. Intrusion took place at a period not earlier than the Tremadoc, and probably not later than that of the May Hill Sandstone.—On the Upper Greensand and Chloritic Marl of Mere and Maiden Bradley in Wiltshire, by A. J. Jukes-Browne and John Scanes. The district dealt with is on the borders of Wiltshire and Somerset. The general succession is as follows, the numbers being given in feet:—Lower Chalk, with Chloritic Marl at the base, 200; sands with calcareous concretions, 3 to 8; sands with siliceous concretions (cherts), 20 to 24; Coarse Greensand, 15; fine grey and buff sands, about 120; sandy marlstone, 15; grey marl and clay (Gault), 90.

Royal Microscopical Society, December 19, 1900.—Mr. Wm. Carruthers, F.R.S., President, in the chair.—Mr. Barton exhibited some new forms of lanterns which could be used for ordinary projection purposes either with or without the microscope. The first was a lantern constructed so as to exclude all light from the room except what passed through the lenses; the manner of using this in connection with a microscope was shown. Another lantern exhibited was larger and more complete, and could be used for all purposes, including enlargements. The excellent definition of this lantern was demonstrated by the exhibition on the screen of photomicrographs of mounted preparations of insects, and of whole insects mounted in balsam. Mr. Barton also exhibited and described several new forms of microscope, with detachable circular stage, &c., and a new form of electric arc lamp for lantern use. A new form of lime-light was also exhibited of great brilliancy, steadiness and silence. Mr. Nelson said he was very much struck with the perfection to which the last-mentioned lamp had been brought, and inquired if the gases had been enriched in any way, and how the light was produced with such complete absence of noise. Mr. Barton said nothing was used but the two gases, and the effect was produced by causing them to impinge upon each other previous to their entrance to the mixing chamber, and by the construction of the chamber itself.

MANCHESTER.

Literary and Philosophical Society, January 8.—Prof. Horace Lamb, F.R.S., President, in the chair.—A discussion was introduced by Mr. W. H. Johnson upon the method of navigation employed by the Norsemen on their voyages between Northern Europe and Greenland and Iceland before the mariner's compass was known. Mr. W. E. Hoyle communicated a note on D'Orbigny's figure of *Onychoteuthis dussumieri*, in which he pointed out the resemblance which it bore to a species of Loligo in the Hamburg Museum. The skin of this specimen was partly covered by convex tubercles, giving it a shagreen-like appearance, which was due to its having undergone partial maceration in the stomach of some cetacean. It was further shown that this appearance might perhaps explain the true nature of a cephalopod described by Prof. Joubin, which he stated to be covered with scales resembling those of a ganoid fish. Dr. Lönnberg had found a similar appearance in a specimen of Onychoteuthis from Magellan's Straits, which on investigation proved not to be due to scales at all, but to a swelling of subcutaneous papillæ in consequence of the maceration to which the animal had been subjected. It seemed, therefore, a reasonable hypothesis that all these scalelike appearances were due to a similar cause.

EDINBURGH.

Mathematical Society, January 11.—Mr. Geo. Duthie, Vice-President, in the chair.—Prof. Allardice read a paper on the nine-point conic, and notes were given by Prof. Steggall, Mr. D. B. Mair and Prof. Jack.

PARIS.

Academy of Sciences, January 7.—M. Fouqué in the chair.—M. Bouquet de la Grye was elected Vice-President for the year 1901.—M. Maurice Lévy, the retiring President, announced the changes in the members and correspondents for the past year.—The President announced the death of Dr. Potain, member in the section of Medicine and Surgery.—On the integrals of total differentials of the third species in the theory of algebraic functions of two variables, by M. Émile Picard.—Observations of the comet 1900*c* (Giacobini), made at the Observatory of Algiers, by MM. Rambaud and Sy. The observations, which were made with the 31·8 cm. equatorial on the nights of December 26 and 27, 1900, show that the comet is a nebulosity of 1′ to 2′ diameter with a feeble central nucleus comparable in intensity with a star of the 13th magnitude.—Observations of the comet 1900*c* (Giacobini) made with the equatorial of the Observatory of Besançon, by M. P. Chofardet. The observations were made on December 25, 1900, and show the comet as a rounded nebula without a tail, with a central stellar nucleus of about the 12th magnitude.—On convex closed surfaces, by M. H. Minkowski.—On the theorem of active forces, by M. H. Duport.—On linear equations with indeterminate points, by M. Ludwig Schlesinger.—On the theory of the equations of mathematical physics, by M. S. Zaremba.—On the absolute value of the magnetic elements on

January 1, by M. Th. Moureaux. The absolute values of the magnetic elements is given for four stations, Parc Saint-Maur, Nice, Perpignan and Val Joyeux. The removal of the magnetic instruments to this last station from Parc Saint-Maur was rendered necessary during the year by the increasing disturbances caused by the development of the electrical tramway system of Paris.—On a new phosphide of tungsten, by M. Ed. Defacqz. All attempts to prepare the tungsten phosphide, WP, at the temperature of the electric furnace were unsuccessful, owing to the fact that at the temperature of boiling copper phosphide the tungsten phosphide is dissociated. By working at the highest attainable temperature of a wind furnace, however, in presence of a large excess of copper phosphide, a well crystallised phosphide was obtained having the composition WP. This forms prismatic crystals of a grey metallic lustre, density 8·5, not attacked by air at the ordinary temperature, but converted into tungstic acid at a red heat.—On some properties of sodium peroxide, by M. George F. Jaubert. Sodium peroxide is commonly described as a white substance which deliquesces slowly when exposed to the air. The author now finds that the colour of this substance when prepared in a perfectly pure state is yellow, and further that it does not liquefy when exposed to the air.—Composition of the hydride and nitride of thorium, by MM. C. Matignon and M. Delépine. At a dull red heat metallic thorium burns in a current of hydrogen forming the hydride ThH. With nitrogen, if the metal be heated somewhat more strongly, the nitride Th_3N_4 is formed, which is rapidly decomposed by hot water with the formation of thoria and ammonia.—Some new reactions of the organo-metallic derivatives, by M. E. E. Blaise. A description of a new general method for the preparation of ketones and ketonic acids. The reagent used is the alkyl magnesium iodide obtained by the action of magnesium upon an alkyl iodide, and this is allowed to react with either a nitrile or an isocyanic ester. Thus in this way the author has obtained propionoacetic ester from cyanacetic ester, diethyl ketone from cyanogen, and substituted anilides from phenyl isocyanate.—Action of methyl-acetylacetone and ethyl-acetylacetone on the diazoic chlorides, by M. G. Favrel. The diazo-chlorides react with methyl- or ethyl-acetylacetone with the elimination of a molecule of acetic acid and formation of a hydrazone. This reaction resembles that of the cyanacetic esters containing substituted acid radicles, and also the reaction between the alkyl-acetylacetic esters and diazobenzene chloride.—On the embryology of *Taenia serrata*, by M. G. Saint-Remy. The author gives reasons for believing that the description given by van Beneden of the young egg, not segmented, is not quite exact, and that this description belongs in reality to a slightly more advanced stage.—On the discovery of an origin of the Swiss Pre-alps, by M. Maurice Lugeon.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 17.

ROYAL SOCIETY, at 4.30.—Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug. Part IV. The Prismatic Cameras: Sir N. Lockyer, K.C.B., F.R.S.—Wave-length Determinations and General Results obtained from a Detailed Examination of Spectra photographed at the Solar Eclipse of January 22, 1898: J. Evershed.—The Thermo-Chemistry of the Alloys of Copper and Zinc: T. J. Baker.

ROYAL INSTITUTION, at 3.—The Origin of Vertebrate Animals: Dr. Arthur Willey.

SOCIETY OF ARTS (Indian Section), at 4.30.—Metalliferous Mining in India: Dr. John W. Evans.

LINNEAN SOCIETY, at 8.—On the Affinities of *Aelurop̄us melanoleucus*, Prof. E. Ray Lankester, F.R.S., with a Description of the Skull and some of the Limb-bones: R. Lydekker, F.R.S.—On the Natural History and Artificial Cultivation of the Pearl Oyster: Dr. H. Lyster Jameson.

CHEMICAL SOCIETY, at 8.—The Preparation of Esters from other Esters of the same Acid: T. S. Patterson and Cyril Dickinson.—Tecomin: a Colouring Matter derived from *Bignonia tecoma*: T. H. Lee.—A New Method for the Measurement of Ionic Velocities in Aqueous Solution: B. D. Steele.—Metal-Ammonia Compounds in Aqueous Solution. II. The Absorptive Powers of Dilute Solutions of Salts of the Alkali Metals: H. M. Dawson and J. McCrae.

FRIDAY, JANUARY 18.

ROYAL INSTITUTION, at 9.—Gases at the Beginning and End of the Century: Prof. J. Dewar, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.—*Possible* discussion upon Mr. H. A. Humphrey's paper on Power Gas and Large Gas-Engines for Central Stations.

MONDAY, JANUARY 21.

VICTORIA INSTITUTE, at 4.30.—Evolution: Rev. G. F. Whidborne.

TUESDAY, JANUARY 22.

ROYAL INSTITUTION, at 3.—Practical Mechanics: Prof. J. A. Ewing, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—On Malay Metal-working (illustrated by Lantern Slides and Experiments): W. Rosenhain.—Slides illustrative of the damage to Stonehenge will also be shown.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Present Condition and Prospects of the Panama Canal Works: J. T. Ford.

MINERALOGICAL SOCIETY, at 8.—Note on an Occurrence of Mirabilite: Dr. Trechmann.—On a Question relative to Extinction-Angles in Rock-Slices: Mr. Harker.—On the Arrangement of the Chemical Atoms in Calc Spar and in some other Crystals: Mr. Barlow.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Imitative *versus* Creative (a Comparison): W. Edwin Tindall.

WEDNESDAY, JANUARY 23.

GEOLOGICAL SOCIETY, at 8.—The Glacial Geology of Victoria, Australia: Prof. J. W. Gregory.—The Origin of the Dunmail Raise (Lake District): R. D. Oldham.

THURSDAY, JANUARY 24.

ROYAL SOCIETY, at 4.30.—*Probable* papers: The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers: Prof. J. Dewar, F.R.S.—Investigations on the Abnormal Outgrowths or Intumescences on *Hibiscus vitifolius*, Linn.: a Study in Experimental Plant Pathology: Miss Elizabeth Dale.—On the Proteid Reaction of Adamkiewicz, with Contributions to the Chemistry of Glyoxylic Acid: F. Gowland Hopkins and S. W. Cole.

ROYAL INSTITUTION, at 3.—Origin of Vertebrate Animals: Dr. Arthur Willey.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Adjourned Discussion: Capacity in Alternate Current Working: W. M. Mordey.

FRIDAY, JANUARY 25.

PHYSICAL SOCIETY, at 5.—The New Physical Laboratories of the Royal College of Science: Prof. A. W. Rücker, Sec.R.S.—Note on an Absolute Method for determining the Hygrometric State of the Atmosphere: E. B. H. Wade.—Exhibition of an Experiment on the Migration of the Ions: S. W. J. Smith.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Sewage Treatment: C. Johnston.

SATURDAY, JANUARY 26.

ROYAL INSTITUTION, at 3.—The Government and People of China: Prof. R. K. Douglas.

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THURSDAY, JANUARY 24, 1901.

THE DEATH OF THE QUEEN.

NOT only the British Empire, but the whole world is mourning the death of one of the most beneficent Sovereigns who has ever adorned a throne. History will for many centuries record the fact that her long reign has been contemporaneous with the most tremendous advances of science which the world has so far seen. In consequence of one of these advances, the civilised communities spread over the whole surface of the planet have mourned simultaneously, and as with one voice, the loss of one universally beloved.

But besides the advances in pure science which have characterised the reign, and the applications of it to the amelioration of human ills and to the greater well-being of humanity, there has been progress along other lines which have been largely dependent upon the Queen's own perfect life and character; her efforts to keep the world's peace, and her intense anxiety that the well-being of even the humblest of her subjects should be fully cared for.

Thanks to all these causes, constantly at work, her glorious reign has possessed a special characteristic, and it has been well called the Victorian age.

What we owe to the circumstances of the time, and Her Majesty's unceasing efforts to mould them for the nation's good, has been well stated in the *Times*.

"Her reign coincides very accurately with a sort of second renaissance, an intellectual movement accomplishing in a brief term more than had been done in preceding centuries. Since the days of Elizabeth there has been no such awakening of the mind of the nation, no such remarkable stride in the path of progress, no such spreading abroad of the British race and British rule over the world at large, as in the period covered by the reign whose end we now have to deplore. In art, in letters, in music, in science, in religion, and, above all, in the moral and material advancement of the mass of the nation, the Victorian age has been a time of extraordinary activity."

To mention these facts is sufficient to recall the increased national activities, along these several lines, not long after Her Majesty began her reign, when she had by her side the late Prince Consort, to whom the nation owed the idea of the Exhibition of 1851 and everything which flowed from it. His wide culture and complete training enabled him to foresee then (that is, half a century ago) what very few of our statesmen recognise now, that brains and complete mastery of all the arts of peace are the most stable bases of a nation's greatness.

Few young rulers were so happy as the Queen in her family life until the lamented death of the Prince Consort—one of the best friends that the English nation has ever had. It was largely owing to his wise foresight and influence that the improvement of our British system of education was undertaken; and in 1852, in the Speech from the Throne, Her Majesty spoke as follows:—

"The advancement of the Fine Arts and of practical Science will be readily recognised by you as worthy the attention of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you, having in view the promotion of these objects, towards which I invite your aid and co-operation."

The death of Prince Albert in 1861 was a blow rom which Her Majesty may be said to have never recovered. It was also a blow to British science which the nation still feels.

The late Lord Playfair told the story how Her Majesty, not long after the commencement of her reign, expressed her desire to show, by distinctions conferred upon them, that she regarded men of science as fellow-workers for the nation's good. He also told us how it came about that at the time this desire was not carried into effect. But during recent years Her Majesty from time to time has shown in this way her interest in scientific progress, and the position of science in the national regard is vastly different to-day from what it was on Her Majesty's accession.

The world is all the poorer for the departure from us of our noble Queen. The nation is stunned: each of her late subjects is mourning a personal loss, but that does not prevent a universal sympathy with those near the throne who, as children or grandchildren, stood at the bedside at so great a passing.

The Royal Family may rest assured that, among the millions of mourners for the loss of one who was truly the Beloved and Revered Mother to all her subjects all over the world, there are none whose sympathy is deeper or more respectful than that felt by the students of science throughout the Empire.

EDITOR.

AN ALPINE CRUST-BASIN.

1: *Das geotektonische Problem der Glarner Alpen.* A. Rothpletz. Pp. vii+251, and Atlas. (Jena: Fischer, 1898.)

2: *Geologische Alpenforschungen.* A. Rothpletz. I. Pp. viii+176. (Munich: J. Lindauersche, 1900.)

A MORE than ordinary interest attaches to these two works by Prof. Rothpletz, as they treat of the boundary district between the Eastern and Western Alps. This district is already famous in geology, and has attracted all comers by its problems. My own opinion regarding its structure had been formed while I wrote my paper on the "Torsion-structure of the Dolomites" in 1898, and was given by me at the British Association Meeting and at the International Geographical Congress in 1899. I then compared the structure of this district with that of the areas of inthrow of various sizes that I had studied in the Dolomites. I described the Glarus-Prättigau area as a local area of depression or crust-basin within the Alps, around which fold-arcs had formed peripherally. Thrust-masses, taking origin in the peripheral arches, had moved towards the centre of the basin. And as across this area of depression the Alpine wave-movement of compression had also passed, the leading strike-curve of the Alps had been superinduced upon the local curves, making various angles with those, so that the actual crust-forms now presented to us were resultant combinations of the local movements round the subordinate basin, with the more extended Alpine movements round the North Italian crust-basins.

Our knowledge of the geology of this district has been vastly extended by Prof. Rothpletz. The actual observations recorded in these works, the discovery of many leading fossils in rocks whose age had hitherto remained doubtful or been erroneously determined, the large number of geological sections and the geological maps, must be regarded as one of the most brilliant achievements in Alpine geology. Two gems of detailed geological mapping may be recommended for careful study, namely, the north-west part of the Glarus district and the fault-blocks of the Rhätikon: (1: Taf. xi., and pp. 166–185; 2: Taf. i., and pp. 69–90.)

In all the leading text-books, the plication of the Alps is referred to lateral compression having acted mainly from the south in the Eastern Alps and rather more from south-east in the Western Alps, hence the curvature of the Alpine strike. Overthrusts are said to have taken place chiefly towards the north on the north side of the central chain, and towards the south on the south side. Glarus, on the north of the central chain, offered an exception to this rule, as according to Prof. Heim's epoch-making work ("Mechanismus der Gebirge," 1878) there had been within Glarus the advance of overthrust masses both from the north and from the south during the last Alpine upheaval.

Prof. Rothpletz contended (1) the existence of an overthrust mass in the south of Glarus, and (2) the correctness of Prof. Heim's conception of a crushed "middle-limb," as theoretically necessary in the process of overthrusting Prof. Rothpletz advocated that the phenomena of overthrusts were akin to differential movements between fault-blocks ("Querschnitt durch die Ost-Alpen," 1894, and "Geotektonische Probleme," 1895). Prof. Rothpletz, in his latest work on Glarus, in 1898, recognises the presence of a thrust-mass in the south of the Glarus area, but treats it as a mass originally continuous with the large thrust-mass on the north (*cf.* p. 211), and concludes from his observations that the whole of this "Glarus thrust-mass" had travelled *from east to west*, a distance of about twenty-five miles from the Rhine valley to the Linth. The rocks that form the *base* of the thrust-plane comprise all the geological horizons from the older gneiss to Oligocene strata, and have been folded along a *curved* strike, east-west near the Linth Valley, but curving round a southern arc to N.E.–S.W. direction nearer the Rhine Valley.

In the south or "Vorderrhein" portion of the "Glarus thrust-mass" the prevailing strike is N.E.–S.W. In the northern portion the rocks of the thrust-mass are folded along a curved strike, curving from S.S.W.–N.N.E. in the vicinity of the Linth Valley round a northern arc to an east-west strike.

In both the basal mass and the overthrust mass the folds have been overcast to the north and north-west, the compression of the folds having been very much stronger in the south than in the north. As many as ten folds overlie one another in the basal mass at Brigelser Horn, and are surmounted by a twisted portion of the thrust-mass with strike veering from S.W.–N.E. to S.N. This curvature is explained by Prof. Rothpletz as probably due to the local resistance offered by two eruptive masses (p. 160).

Three higher tiers of thrust-masses are present on the west of the Linth Valley in the Glärnisch Mountain; two of these thrust-masses continue in curved direction north-eastward to the Schild Mountain and Lake Walen. The names given to them by Prof. Rothpletz are the Schild, Urner and Schwyz thrust-masses. Prof. Rothpletz says these masses have travelled from the north-west, but he expressly states his opinion that they advanced subsequently to one another and subsequently to the advance of the Glarus mass from the east, or locally south-east (p. 216).

Looking now at the second work, which treats of the east side of the Rhine Valley, the most important result is the description of a Rhätikon and Silvretta overthrust from the east. Prof. Rothpletz proves that the rocks of the Rhätikon Chain rest on a basal mass which is the natural continuation of the Glarus thrust-mass eastward, and he concludes that the Rhätikon mountain mass travelled from the Montafon Valley to the Rhine Valley, about nineteen miles from east to west. Tracing the origin of this thrust southward, he finds the rocks of the Silvretta Massive have been thrust eastward above the basal mass of the Prättigau, and still farther south the overthrusts are continued in the Lenz and Oberhalbstein mountain-group. The independence of the over-thrusting and the folding processes may, in Prof. Rothpletz's opinion, be concluded from the fact that the direction which has been followed by the thrust-mass frequently makes an angle with the strike of the folds. He attributes the difficulties which have hitherto attended the solution of the geological problems here:—

(1) Partly to the fact that all these overthrust masses and the basal mass in the district of the Glarus and Rhätikon have been pushed subsequently towards the north-west above the folds in the outer, or "molasse," zone of the Alps; thereby the original inclinations of the several thrust-planes have been altered or masked. (2) Partly to subsequent displacements effected along longitudinal and transverse fault-lines. (3) Partly also to the insufficient knowledge of the details of the stratigraphical succession as exhibited in the different facies of the Helvetic and the Austrian Alps.

What occurs to me in reading these works is that a great number of the observations which Prof. Rothpletz has given are unaccounted for in the conception of the structure as yet presented by that author. The conception does not go far enough, it misses the significance of the author's carefully collected data of strike and dip which prove intercrossing and curved strikes to be really the leading structural feature of the district. Prof. Rothpletz does not offer any explanation of that remarkable fault-curve in his map which follows the Linth Valley N.N.E. as far as the Schild Mountain, then curves east to the Sees Valley, and again S.S.E. and S.E. to Sargans; or interpret that other zig-zagging fault which curves round the south of the Rhätikon and south-east through the Falknis Chain, then southward in the Silvretta Massive, and again south-west through the Lenzerhorn Chain. According to my experience in the Dolomites, and having regard to the variations of the strike in the folds of the thrust-masses, I would consider these as primarily strike-faults through curved folds that formed round a local crust-basin (*cf. Geological Magazine*, 1894, pp. 54-58; *Q.J.G.S.*, 1899; *Geographical Journal*, 1900).

Let any one glance at my figure of the torsion-curves round the northern periphery of the Adriatic crust-basin (*L.C.*, 1899, fig. 22). The curves are convex to the north; the chief overthrusts have come from the W.N.W., N.W., N. and N.E., and have moved centripetally with reference to a centre in the Adriatic depression. Or compare the much smaller fold-arc of the Gröden Pass arch and its accompanying fault-curve from Plon over the Gröden Pass to Ruon and Corvara.

The arc of origin of the thrust is convex to the north; the thrust-mass has advanced southward and been broken up into several fault-blocks by faults, for the most part, transverse to the arc of origin. Return, now, to the map of the Glarus (Rothpletz's Atlas, Taf. xi.), and it will be clear that there is a repetition of similar geological phenomena. Even the details in the typical fold-forms are essentially alike (compare Rothpletz, Plate v., Figs. 5, 6, with sections 4, 5, 6 and 16, 17 in my "Torsion-structure.") In passing, it may be said that this similarity is in so far important, as it shows how much closer is the resemblance in the structure of the Eastern and Western Alps than has been usually supposed.

My interpretation of Prof. Rothpletz's data may now be indicated. His description of the continuation of the Glarus thrust-mass westward and eastward from the Mürtschen-Stock shows that it is broken by numerous faults along which both horizontal and vertical displacements have taken place, and that the typical fold-form has undergone quite different modes and degrees of compression in the several fault-blocks. From the Firz Stock in the east to the Linth Valley in the west one is presented with a series of uplifts and downthrows having the character of incipient folds, where arches and troughs are limited by steep septa or faults. The Mürtschen and Firz group is buckled into three main fault-blocks, the central of which is the highest, while the Schild group is depressed relatively to the eastern group, but within itself shows also a central upthrow flanked by downthrown blocks. The faults which have determined this cross-buckling are practically transverse to the local curvature of the strike. They therefore represent what I termed "radial" faults, or the fault-radii of a fold-arc (*Q.J.G.S.*, 1899, p. 604). This cross-blocking of a fold-arc demonstrates the action of horizontal pressures parallel with the direction of the curved strike, in addition to the action of horizontal pressures rectangularly to the fold-arc, and indicates that we have here *a system of local pressures complete in itself.*

I further note from Prof. Rothpletz's sections that the horizontal compression along N.W.-S.E. lines has been much stronger in the case of the Schild group than in that of the Mürtschen group (1: Taf. vii., Figs. 8, 15). The N.W.-S.E. strike represents the general Alpine strike at this part of the Alps, and it will be observed that in the Schild area the "Alpine" strike coincides, or is very slightly oblique, with the local strike, hence the resultant crust-deformation here represents the sum of two almost similarly-acting sets of pressures. Moreover, it is well known that the Alpine movements became rapidly less intense from west to east in this boundary district between the Western and Eastern Alps. The predominance of the N.E.-S.W. or "Alpine" strike in the basal mass of plastic strata, and the general overcasting to N. and N.W. of the folds, both in the basal mass and the thrust-mass, together with oblique overthrusting between the fault-blocks, seem to me conclusive evidence that the "Alpine" movements were not only subsequent to the formation of the fold-arcs, but also subsequent to the initiation of the N.N.W.-S.S.E. faults through the fold-arc (*cf.* footnote, *Q.J.G.S.*, 1899, p. 559).

Take, again, the Rhätikon thrust-mass in Prof. Rothpletz's map (2, p. 161). Faults virgate from Bludenz to W.S.W. and S.W., and cut the curved fault which separates the Rhätikon and the Falknis crust-blocks. These faults I take to have been originally fault-radii of a Rhätikon fold-arc formed round the north-east of the crust-basin. The overthrust of that mass has taken place in the main *from* this direction towards the south-west. Each fault-block in this thrust-mass is gently folded between the Montafon Valley and the Falknis, and a N.W.-S.E. strike is present in the Gorvion and other parts close to the Falknis Chain. This strike, together with the folding, indicates the action of horizontal pressures from the north-east; and the virgating group of faults across the Rhätikon indicates the action of horizontal strains parallel with the curved strike of the fold-arc, effecting transverse fractures in the sense of fault-radii of the arc. Hence there is in the Rhätikon evidence of a complete set of local phenomena of compression

analogous in character to those which appear in the north-west portion of the Glarus-Prättigau crust-basin.

The Falknis block is an anticlinal block separated by curved strike-faults from the Rhätikon on the north and he Prättigau on the south, and cut by north-south faults. It shows, therefore, the general east-west strike and transverse fractures characteristic of the eastern Alps. The curvature of the strike in the west part of the Falknis Chain from east-west to north-west may, like the curvature of the fault at this part, be taken to signify a resultant or compensatory divergence due to the inter-crossing of the local and the east-Alpine strike. Similarly, at the east end of the Falknis, the east-west strike curves to the south-east. The Falknis fault-block is a replica of the Gröden Pass anticlinal fault-block. The east-west strike is the dominant strike of the Eastern Alps, trending to E.S.E. in South Tyrol. It is acknowledged to have been an ancient strike along which movements have recurred in various ages in the Eastern Alps, although during the Pliocene movement the horizontal compressions from north and south were much less intense in the eastern than in the western Alps. This fact expresses the chief difference which obtains between the structures on the east and the west of the Rhine Valley. The fold-arcs round the east of the Glarus-Prättigau crust-basin have not sustained the same degree of compression during the subsequent Alpine folding as those round the western periphery; neither have the horizontal pressures acted quite from the same directions, the Alpine pressures having acted across Glarus towards the N.W., and across the Prättigau and Rhätikon more towards the north.

The eastern thrust from the Silvretta Massive gives expression both to the horizontal compressions rectangular to the eastern fold-arc of the local crust-basin, and to the horizontal strains acting along the strike of the Alpine curve. In the greater Alpine curve, just as in the case of the smaller curve of the local basin, the formation of radial uplifts and downthrows is determined by these tangential pressures. And it is this cross-system which is more particularly accountable for the diagonal N.N.W. and N.N.E. and transverse faults and thrust-fractures in the Alps.

In my interpretation the Lenzerhorn Chain represents fold-arcs on the south-east of the local basin. The curved strike veers here from north-east to west, and there are also fault-radii in N.N.W. direction. The oblique shearing that has occurred here is apparently stronger than in the Rhätikon, but not nearly so strong as in the Brigels and Vorderrhein Chain, which represents the southern fold-arc in the Glarus district. My inference is that the original Glarus-Prättigau crust-basin with its peripheral folds has been cut into two unequal halves by the development of the Rhine fracture during the later Alpine movements. The Rhätikon and the Glarus have been rent asunder at the north of a radial Alpine fracture. The regional Alpine movements have superinduced wider curves above the local curves and have affected the two halves of the basin with different degrees of intensity, so that the eastern half occupies a broader area from north to south than the more strongly crumpled western half.

Hence the ground-work of the structure in this region is based upon *intersecting fold-arcs*, and all the additional details supplied by Prof. Rothpletz can be adopted in the scheme of Alpine geology which I demonstrated in 1899 upon the basis of the "fold-arc" and the "unit-area of depression" surrounded by torsion-curves of strike (Report Intern. Geogr. Congr. Berlin, 1899). The science of geology finds itself, at the threshhold of this new century, entering upon a development of research in which advance can only be made if the student of earth-structures can bring to bear upon his observations a sound knowledge of the laws of higher mathematics, dynamics and physics. And, if I may make a forecast, it is that structural geology will be ere long grouped in our university curricula with these exact branches of science.

MARIA M. OGILVIE-GORDON.

THE ZOOLOGICAL RECORD FOR 1899.

The Zoological Record. Vol. xxxvi. Being Records of Zoological Literature Relating Chiefly to the year 1899. Edited by D. Sharp. (London: Gurney and Jackson, 1900.) Printed for the Zoological Society.

THE editor of this invaluable record is to be congratulated on its early issue, the present volume having been in the hands of the public during the first week in December. The amount of energy on his part necessary, in order to secure punctuality in the delivery of their quota of manuscript from twelve contributors, can scarcely be realised except by those who have undergone a similar experience. This early appearance of the volume is, however, in part due to the circumstance that the contributors are now instructed not to await the arrival of the whole of the year's literature, but to be content with as much as is to hand at the date when their manuscript is required. That this decision is a wise one there can be no doubt, for it is much more important to issue the record at as early a date as practicable, than it is to insist on its containing the whole available literature of the year to which it is specially devoted.

This leads naturally to the remark that some want of uniformity is noticeable with regard to the inclusion of portions of certain serials in each year's record. For instance, the fourth part of the volume of the *Proceedings* of the Zoological Society of London for each year is not issued till well on in the following year. Now we find that in the records of mammals and birds, the contents of this part are quoted in the year to which they nominally belong, while they are omitted in the reptile and fish records. It is not for us to discuss which plan is the better, but we do urge that strict uniformity in this respect should be insisted upon by the editor.

Nor is this the only instance in which that functionary does not appear to have his team sufficiently well in hand. As the record of insects is by the editor himself, we may take this as the model which ought to be strictly followed by all his subordinates. This record is preceded by a carefully written introduction, bringing into special notice the leading features in the year's work; the papers are numbered, and where a series of new species are described in any particular genus, they are collectively designated as such at the end of the paragraph. In the

main, this admirable model is copied in the mammal record; but in the bird section the introductory notice is confined to five lines, and the number of unnecessary repetitions of "n. sp." (as on page 38) wastes much valuable space. In the reptile and fish records no introduction at all is given, and the papers are not numbered. Introductions are likewise wanting to the Bryozoa and Cœlenterata records. On the other hand, in the Tunicate record the notices of work accomplished are, compared with other sections, disproportionately long and too verbose.

Again, there are many minute details where more supervision on the part of the editor might, we think, have been devisable. For example, some recorders use "P. Z. S.," and others "P. Zool. Soc., London," for a familiar zoological journal. In the case of another journal we find it abbreviated to "P. New England Zool. Club" in the editorial list at the commencement of the volume; but in the mammal record (p. 4) it is quoted as "P. New England Club"; and in the bird record (p. 39) as "New England Zool. Club." Again, on p. 4 of the reptile record we find the abbreviation "Bull. Philad. Mus.," for which there is no corresponding entry in the serial list.

As an example of another type of what we venture to call lack of smartness, it may be noticed that on p. 38 of the bird record the entry relating to temperature should have come under the heading of Ratitæ instead of under one of the subdivisions of the same; and a similar remark applies to the second entry under the heading Accipitriformes, on p. 47. Again, on p. 39 of the same record, we fail to see why initials are prefixed to some authors' names and not to others; and why a well-known ornithologist is alluded to in one line as W.R. Ogilvie Grant and a few lines later on simply as Grant. In our opinion, such initials, except when there are two authors of the same name, should always be omitted, whereby much space would be saved. But here, as elsewhere, we crave above all things for rigid uniformity, which, in our opinion, should be made a *sine quâ non* by the editor.

We should also think it an advantage if it were definitely decided whether reviews of papers are to be included in the record. Such reviews are quoted in the Echinoderm record, but are omitted in the majority of the others. And here we may take the opportunity of inquiring why the names of authors in the Echinoderm record are printed in much larger type than in the other sections of the volume. Much valuable space is also wasted in this record by the very unnecessary multiplication of paragraphs. Catalogue numbers are also added to the papers, which is not done elsewhere.

Turning from the unpleasant task of fault-finding to the more congenial duty of commendation, it may be said that, apart from trivial errors and what we regard as imperfections, the work on the whole has been carried out in a most excellent manner alike by the editor and his contributors. With the aid of the admirable subject-index which has been introduced of late years by Dr. Sharp in each record it is now practicable for a worker in any special branch of morphology—say histology of the eye—to find out what has been done in that particular subject in each group of the animal kingdom. The record of new species and sub-species seems to be as well kept as in previous years, and at present shows no signs of diminution in length. Of course there are some omissions which ought not to have occurred—notably one of a so-called new species of reindeer by the mammalian recorder; but these, it is to be hoped, will be filled up in the next year's issue.

And here it may be remarked that it is a great pity that certain scientific bodies are so dilatory in despatching their publications. For instance, the library of the Natural History Branch of the British Museum, on which so many of the contributors to the *Record* depend for their material, only received in November last certain parts of the *Bulletin* of the Paris Museum which were issued in 1899. Consequently the names of several species of mammals published during the year do not appear in the present volume, and similar omissions not improbably occur in other groups.

A feature of Dr. Sharp's insect record is the inclusion of an obituary list. There is no doubt that such a list is frequently very useful, but if a separate one were made for each division of the record a very unnecessary repetition of names would occur, and there would be some names whose position it would be difficult to allocate. A preferable plan, we think, would be to give a general obituary list, indicating the special subject or subjects connected with each name by appropriate letters.

We believe ourselves justified in saying that the Council of the Zoological Society have resolved to continue the issue of the *Record* for at least another year; and although to some it may appear an unnecessary expenditure of time and money to do work twice over, the convenience of having a special record of zoological work is so great that the apparent waste of energy may be justified.

As one who has worked for some years under Dr. Sharp's supervision, the writer of this review may take the opportunity of acknowledging the extreme lightness of the pressure of the editorial yoke, and the courtesy with which his own suggestions or objections have always been received.

R. L.

OUR BOOK SHELF.

Practical Lessons in Metal Turning. By Percival Marshall. Pp. 166. (London: Dawbarn and Ward, Ltd., no date). Price 2*s.* net.

OF all the different trades included in the term "mechanical engineering," that of the turner is probably as interesting as any, and seems to appeal to the amateur mechanic rather more than the others, for, given an efficient foot lathe, the work done is of general interest.

The book under notice will be found to contain information of much value to the happy possessor of a lathe, more particularly to the apprentice or amateur in the early stages of learning his trade; and in dealing with his subject the author prefers to devote the space at his disposal to a description of how a lathe is worked, rather than to how it is made.

The various processes are clearly dealt with in nine chapters, commencing with the important question of cutting tools with their proper angles for clearance, cutting and top-rake when working various materials We note, however, that the question of cutting speeds appears to have been overlooked, and this is unfortunate because it leaves the apprentice or amateur very much in the dark at the very beginning. Further on, measuring appliances are dealt with. More should have been made of micrometer callipers, so largely used in the States. These are not even illustrated.

On chucks and mandrils our author has much to say, and useful advice is given on how to centre work for the lathe, the book concluding with a chapter on screw-cutting of a rudimentary nature, sufficient, however, to give the amateur a good start in this somewhat difficult subject.

Taken as a whole, the little book will be of much use to the young apprentice and amateur. It flavours more of the workshop than of the technical school, which is very much in its favour.

Principles of Plant Culture. By Prof. E. S. Goff. Second Edition. Pp. 287. (Wisconsin: Madison. Published by the Author, 1899.)

MANY of our county councils have now instituted training colleges for teachers, and laboratories for the instruction of pupils in the elements of agriculture and horticulture. In such establishments Mr. Goff's little treatise, which is now in a second edition, will be most useful. The phenomena of the life of plants are clearly explained, and the details of internal structure sufficiently set forth. The application of these facts to the practical details of cultivation is shown, and stress laid upon the conditions that are propitious, as well as on those that are adverse, to plants. Numerous illustrations are given and, as an appendix, is provided a syllabus of laboratory work containing directions whereby the pupil may be assisted in realising for himself the teachings of the text.

It is a book suitable not only for those who have the advantage of access to a laboratory, but also for those who have to acquire a knowledge of plant-life without the assistance of a teacher.

Photography in Colours. (Photography Bookshelf, No. 5.) By R. Child Bayley. Pp. 74. (London: Iliffe, Sons and Sturmey, Ltd., 1900.)

THERE are probably many people who wish to obtain a general survey of the different attempts that have been made to solve the fascinating problem of "photography in colours" without necessarily entering deeply, or at all, into the practice of any one or more methods. Every one who practises photography should, however, have an intelligent idea of the various processes in use, even if such knowledge amounts to a mere outline of the principles involved. Until now there has been no book devoted to such a summary, so the one before us is very welcome for filling such a gap in our literature.

The author has naturally avoided all technicalities, and confined himself strictly to the explanation of the fundamental principles on which each method is based. The book, it may be mentioned, originated from the editorial articles written by the author for *Photography*, which have been revised and published in this handy form.

The Romance of the Earth. By A. W. Bickerton. Pp. 181. (London: Swan Sonnenschein & Co., Ltd., 1900.) Price 2*s.* 6*d.*

THIS is an attempt to trace, in a popular manner, the history of the earth from the time it had a separate existence to the present, together with that of its fauna and flora. As giving an idea of the subjects touched upon it may be mentioned that among the titles of the various chapters are "The Beginning of the Earth," "Earth-Sculpturing," "Ice-Ages," "Evolution," "Embryology" and "Organic Ascent." In order to make the story a connected one, the author admits that where facts have not been available he has permitted himself "to speculate, to make deductions from the accepted laws of nature." To this there could be no objection had some clear indication been given whereby the reader might distinguish the generally accepted ideas from the personal views of the author. Still, the book is well written and appropriately illustrated, and provides an interesting first course of reading on some of the greater problems of science.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Directions of Spirals in Horns.

THE direction of the spiral in the horns of Bovidæ is, I think, a less simple matter than might be inferred from Mr. G. Wherry's interesting note in NATURE for January 10, p. 252; at all events so far as sheep and goats are concerned.

The only wild goat with truly spiral horns is the markhor, *Capra falconeri*, in all varieties of which the spiral is, as Mr. Wherry states, "crossed" (right horn twisting to left, left horn to right), but in the great majority of tame goats the reverse is the case, the horns being "homonymous." This was pointed out to me many years ago by the late Edward Blyth, and I have been able to confirm his observations repeatedly in countries where tame goats abound, both in India and in North-East Africa. The rule is not without exceptions, a few tame goats having horns coiled like the wild markhor. I have already called attention to these facts in the "Fauna of British India, Mammalia," p. 508. The "homonymous" spiral in tame goats is the more interesting because it is probable that most of them are derived from the wild *Capra aegagrus*, which has horns curving backwards, not spiral.

As regards sheep, the horns in all the *Ovis ammon* group, including *O. poli*, are "homonymous," as Mr. Wherry says. But the bharal, *Ovis nahura*, has its horns arranged on the reversed or "crossed" system. It is true that the bharal is in some other respects intermediate between sheep and goats.

W. T. BLANFORD.

The "Usefulness" of Science.

IN your interesting article on "The New Century" in the January 3 number of NATURE, I notice that you endorse M. Lévy's account of the usefulness of "useless" studies and even proceed to suggest that "all our progress has come from the study of what was useless at the time it was studied." Now while fully agreeing with your main argument, it seems to me that this goes too far. Certainly M. Lévy's illustrations do not prove it. For it so happens that the early astronomical observations, to which he appeals, so far from being useless in the eyes of those who made them, were believed to be of the utmost practical importance. In fact, it may be doubted whether the study of astronomy has ever again been prosecuted in so directly utilitarian a spirit as in its infancy. For, quite apart from the practical need of determining the succession of the seasons, which M. Lévy seems to have strangely overlooked, it was generally believed that the observation of the heavenly bodies was "useful" as a method of forecasting terrestrial events. Astronomy was the offspring of astrology, and assiduously practised because no distinction had yet been made between those heavenly bodies which made great practical differences to human affairs, like the sun and the moon, and those whose influence was inappreciable. Furthermore, it must be remembered that these same bodies were regarded as literally deities of the highest order, so that their observation was a religious rather than a scientific act. This veneration of the heavenly bodies, moreover, persists throughout Greek science, and even Aristotle regards them as composed of a purer and diviner material than anything "sublunary." So that, when he advocates the "useless" θεωρία of astronomy and mathematics as the highest exercise of human faculty, he does *not* mean "seek knowledge for its own sake," but rather "raise yourself to the contemplation of what is nobler and diviner than anything earthly." For the eternal and immutable truths of mathematics also were regarded as being of more than human validity. Hence it seems a mistake to call these primitive researches useless because we do not happen to believe in the use they were supposed to have.

And this suggests a further scruple. Does not the doctrine that the "useful" discoveries arise out of the study of the "useless" come perilously near to a psychological paradox? For how can any one rationally pursue the study of what he at the time conceives to be useless? It must at least be useful to him, *i.e.* satisfy his desires in some way or other. In the last resort, what can the useful be but that which satisfies some human desire, subserves

some human purpose? In the widest sense, therefore, all knowledge which is desired must be useful in some way and for some purposes, and, even on the most narrowly "utilitarian" interpretation, the useful is nothing else or more than what satisfies desire—except that an attempt is made to restrict it to the satisfaction of a very limited set of desires. An absolutely useless method or study would be one that could not be worked in any conceivable manner or for any conceivable purpose, *i.e.* it would be not merely useless, but *false.* The proper defence, therefore, of the so-called "useless" researches seems to me to consist in showing in the first place that the context of a science requires them, and in the second in pointing out that it has always, so far, proved possible to find a directly practical application for what is organically connected with a system of knowledge.

Corpus Christi College, Oxford. F. C. S. SCHILLER.

The Field-mice and Wrens of St. Kilda and Shetland.

IN his notice of Messrs. A. H. Evans and T. E. Buckley's "Fauna of the Shetlands" (NATURE, May 24, 1900, pp. 75 and 76), your reviewer regrets that the authors are silent in regard to the special characters of the Shetland field-mouse, in view of my own recent recognition of a peculiar representation of this type in St. Kilda. It may be interesting to point out that in a recent paper on geographical and individual variation in *Mus sylvaticus* and its allies (*P.Z.S.*, 1900, p. 387), I found myself unable to separate the Shetland field-mouse (specimens of which I had fortunately been able to examine), at least at present, from that of Great Britain generally. I would not, however, therefore necessarily bind myself to follow your reviewer in his suggestion that the comparative distinctness of the local forms of wren and field-mouse may guide us in forming a decision as to the relative periods during which St. Kilda and the Shetlands have been separated from the mainland. So many factors seem to be brought into play in the evolution of a local race or subspecies that it is, I fear, unsafe to rely too much on such points, and I have a strong suspicion that the influence of the environment has been too little taken into account by recent writers. At all events the field-mouse of Iceland would, it might be thought, show remarkable deviations from the mice of Western Europe, yet the little that we know of it only shows us how closely allied it is to *Mus sylvaticus* proper.

As regards the wrens of Iceland and of the various Scotch islands, attention may be directed to an interesting series of measurements of wings given by Mr. R. M. Barrington in a footnote to p. 641 of his book on "The Migration of Birds as Observed at the Irish Lighthouses and Lightships." These seem to show a gradual diminution in size from the large *Troglodytes borealis* of Iceland through the Shetland wren, which, although smaller than *T. borealis*, seems to be larger than *T. hirtensis* of St. Kilda; the latter exceeds in size the wrens of Ireland. But no doubt intermediates occur, and a wing received from the lighthouse on the Tuskar rock off the Wexford coast in October, 1888, equals that of a specimen from St. Kilda, whence, perhaps, it may have been a migrant.

G. E. H. BARRETT-HAMILTON.

Kilmanock, Arthurstown, Waterford, Ireland.

Sexual Dimorphism.

IF Prof. Meldola does not suppose that all spontaneous variations are limited in inheritance to one sex, he is logically bound to admit that the theory of sexual selection does not explain unisexual inheritance. There can be no possibility of verbal juggle in my arguments, because I define a secondary sexual character as one that is affected by castration, one that does not develop normally after removal of the generative organs, a spontaneous variation as one that is not produced by the conditions of life.

But it is not my theory that "the stimulations which produced a male character necessitate the restriction of that character to the male," and therefore I am not affected by the dilemma in which Prof. Meldola thinks I am placed. On p. 94 of my book will be found these words:—

"It is possible that unisexual characters originally developed by special stimulations related to reproduction, tend sooner or later to be inherited in common by all individuals of the species, that, considered in relation to periods of evolution, their sexual limitation is only temporary."

I fear that Prof. Meldola has not yet sufficiently considered my theory. J. T. CUNNINGHAM.

Penzance, January 11.

THE theory of sexual selection never pretended to *explain* unisexual inheritance. Its author started with a fact:—"Inasmuch as peculiarities often appear under domestication in one sex and become hereditarily attached to that sex, so no doubt it will be under nature" ("Origin of Species," 6th ed. p. 69).[1] Neither does the theory of natural selection pretend to *explain* ordinary, *i.e.* bisexual, inheritance. But Mr. Cunningham pretends that his theory does explain unisexual inheritance, and having in spite of the statement contained in the concluding sentence of the above letter—given very full consideration to his views, I have come to the opposite conclusion. I repeat that his theory does not explain unisexual inheritance.

Mr. Cunningham has now given a further and more restricted "definition" of secondary sexual characters. In this he has not only gone far beyond Darwin, but he has virtually cancelled at least half of his own book. The whole of the evidence that characters developed in one sex are latent in the other was summarised by Darwin in 1868:—"We thus see that in many, probably in all cases, the secondary characters of each sex lie dormant or latent in the opposite sex, ready to be evolved under peculiar circumstances" ("Variation of Animals and Plants," 1st ed. vol. ii. p. 52). All the evidence with regard to secondary sexual characters which Darwin considered in arriving at the above conclusion was based on cases observed in mammals and birds, and, with his well-known caution, he only admits probability in extending it to all cases. But Mr. Cunningham now has converted Darwin's cautiously expressed probability into a "definition"! In doing this he has practically wiped out the whole body of material relating to classes other than mammals and birds which he has brought together in his own work. I confess that I have not of late years been able to follow very closely the progress of knowledge in this direction, but, so far as I know, there is no single observation, with the exception, perhaps, of *Stylopised* bees, which would bring the secondary sexual characters of fishes, reptiles, crustacea, insects, &c., within Mr. Cunningham's definition. Is there any known case among these lower groups where the "removal of the generative organs" (to use Mr. Cunningham's own expression) leads to the appearance of the characters of one sex in individuals of the other sex?

There is another inexplicable statement in the above letter: "It is not my theory that 'the stimulations which produced a male character necessitate the restriction of that character to the male.'" I must again quote Mr. Cunningham's own remark of December 29, 1900. "My theory is that they (the variations) were so limited in development because they were due to stimulations similarly limited" (NATURE, January 10, p. 252). If this does not mean that he is attempting to explain the sexual limitation of characters by "stimulations" applied originally to the sex in which they are now developed, then it appears that he has abandoned his fundamental proposition, viz., that his theory *explains* unisexual inheritance. The restriction of this sexually limited inheritance by considering it temporary instead of permanent, as indicated in the passage quoted by Mr. Cunningham at the conclusion of the above letter, does not affect the argument in any way. We still have to learn how and why the theory of "stimulations" explains unisexual inheritance, even if the latter be only temporary.

I venture to think that editorial hospitality has been sufficiently taxed in connection with this subject. So far as I am concerned I must beg Mr. Cunningham to consider the discussion as closed. The issue is before the readers of these columns, and I do not think that any further advance is likely to be made by mere iteration and reiteration. I consider that indirectly the author of "Sexual Dimorphism" has done excellent service to the cause of Darwinian evolution by enabling us to realise how a well-conceived and well-worked-out application of Lamarckian principles completely breaks down on critical examination. R. MELDOLA.

January 12.

Very Cold Days.

THE following account of days on which the minimum temperature was under 20° (at Greenwich) may be found instructive.

There have been 162 of these very cold days in the last sixty

[1] "We may conclude that one cause, though not the sole cause, of characters being exclusively inherited by one sex, is their development at a late age" ("Descent of Man," &c. 1st ed. vol. i. p. 295). This is the utmost extent of Darwin's application of the evidence in discussing the sexual limitation of certain characters. The explanation is based on the hypothesis of "pangenesis" (*loc. cit.* p. 284).

years; thus averaging about 2·7 days annually. (The annual number of frost days is about 55.)

The year distribution is as follows:—

1841	7	1856	2	1871	3	1886	4
1842	—	1857	—	1872	—	1887	4
1843	—	1858	—	1873	—	1888	3
1844	1	1859	3	1874	3	1889	4
1845	4	1860	3	1875	1	1890	7
1846	3	1861	5	1876	2	1891	6
1847	6	1862	—	1877	—	1892	2
1848	1	1863	—	1878	3	1893	5
1849	2	1864	4	1879	5	1894	5
1850	—	1865	4	1880	5	1895	11
1851	—	1866	—	1881	10	1896	—
1852	—	1867	7	1882	—	1897	—
1853	1	1868	—	1883	—	1898	—
1854	2	1869	—	1884	—	1899	1
1855	14	1870	7	1885	—	1900	2
							162

The greatest number in any one year is 14, in 1855. Next come 1895 with 11, 1881 with 10, four with 7 each, &c. Considering *winters* instead of *years*, the highest number is 12, in 1854–55. On the other hand there are 22 years with none of these days, *i.e.* more than a third of the whole. We do not find more than *four* such years in succession; such a group is presented in 1882–85.

The distribution in months is as follows:—

Jan.	Feb.	Mar.	Nov.	Dec.	
68	42	5	2	45	= 162

Thus, January is *facile princeps*. February and December are nearly equal. The days are rare in March, and most rare in November. Of the two in November, one was on the 30th, in 1856 (19°·4), the other on the 28th, in 1890 (18°·3). The latest in March was on the 14th, in 1845 (13°·1).

Speaking roughly, we seem to have had an increase in those very cold days. Grouping in decades we find this:—

1841–50	1851–60	1861–70	1871–80	1881–90	1891–1900
24	25	27	22	32	32

The first three total 76; the last three 86. To put it otherwise, the thirty consecutive years ending 1895 had more of those days than any other thirty-year group.

Do these days present any definite relation to the sun-spot cycle? I think we may discern (as in the case of frost days) a tendency to greater cold before a maximum of sun-spots than after. This may be variously shown; here *e.g.* is one way:

Compare the group of years from the seventh after a maximum year to the next maximum year (inclusive) with the six years after the latter maximum. We may construct a table as follows:

	a Annual Average.		*b* Annual Average.	Relation *a* to *b*.
1844–48	3·0	1849–54	0·8	+2·2
1855–60	3·7	1861–66	2·2	+1·5
1867–70	3·5	1871–76	1·5	+2·0
1877–83	3·3	1884–89	2·5	+0·8
1890–93	5·0	1894–99	2·8	+2 2
				Av. +1·7

Thus the group of years ending with a maximum year shows an average which is always in excess of that of the six-year group following.

These very cold days are often found in groups. Among the longest are February 16–22, 1855, and February 5–10, 1895.

I may close with a list of the ten coldest days:—

		Min. °
1.	January 9, 1841	4·0
2.	January 5, 1867	6·6
3.	February 8, 1895	6·9
4.	February 12, 1845	7·7
5.	January 4, 1867	7 7
6.	December 25, 1860	8 0
7.	February 7, 1895	9·6
8.	January 8, 1841	9·8
9.	December 25, 1870	9·8
10.	December 29, 1860	10·0

ALEX. B. MACDOWALL.

NATIONAL PHYSICAL LABORATORY.[1]

THE first annual report of the Executive Committee of the laboratory, which was laid before the Royal Society at its annual meeting, is in some respects disappointing. It contains a record of much valuable labour, rendered useless by the opposition to the site on the Old Deer Park at Richmond, which had been selected for the laboratory; while the delays caused by that opposition have made the progress of the scheme very slow.

The Richmond site was chosen by Lord Rayleigh's committee, and approved by the Treasury; the director's first task, after taking up his duties, was to visit the Reichsanstalt and the Bureau International at Sèvres. The courtesy of the authorities of these two institutions is suitably acknowledged in the report, and is another evidence of the international character of science. Meanwhile, in order that the new laboratory might, from the beginning, adapt itself to real wants, various committees had been considering the questions which seemed to press most urgently for solution. With their reports before them, the executive committee prepared plans, and authority was given in June last to obtain tenders for the work. Then followed a delay of some four months. During the summer a deputation from the Royal Society waited on Mr. Hanbury, urging that the original scheme should go on; but towards the end of October it was announced that Her Majesty had been graciously pleased to assign Bushy House and grounds for the purposes of the laboratory, and that in order to meet the additional capital expenditure involved, the Government were prepared to ask Parliament to raise the grant of 12,000*l.* for building to 14,000*l.* This was accepted by the Council of the Royal Society, but it was pointed out that, to quote the words of the report:—

The executive committee "cannot, however, conceal from themselves that it will be very difficult for them to maintain and administer a national physical laboratory on the Bushy site for the amount annually allowed by the Treasury, and they fear that it may be necessary for them to press, in the near future, for an addition to that allowance."

Meanwhile, plan-making had to begin again. With the very cordial assistance of the Office of Works a new scheme was prepared and approved, and now the workmen are on the ground and the alterations have commenced.

Fortunately, the structural changes necessary will be remarkably small.

Bushy House is in many respects well suited, as it stands, for a physical laboratory; the basement, however, was dark and damp, and the whole sanitary arrangements needed reconstruction. The basement is to be improved by the construction of a dry area round the house, and the insertion of larger windows; the present flagged floor is to be removed, and to be replaced by concrete and cement. Modern drainage is to be introduced everywhere, and in place of the cess-pools now in use, connection is to be made with the public sewer; this necessitates a main drain some 300 yards long.

The house itself consists of a central block about 70 feet square, containing a basement and ground floor with two floors over. The ground floor rests on brick groining, forming the roof of the basement; it is thus possible to secure steady supports for apparatus at almost any point; the building is very substantial, and it will be easy to maintain a uniform temperature throughout the basement.

The front of the house faces east approximately; unfortunately, the two main rooms of the central block on the first floor look south and west respectively; in

[1] Report of the Executive Committee for 1900, and Programme of Work for 1901.

other respects they will make good laboratories, requiring only the provision of some steady supports, and, in common with the rest of the house, arrangements for heating and for the supply of gas, water and electricity for light and power.

But besides this main block, which is some 50 feet in height, there are five large wings, one at each corner and a fifth adjacent to the north front. This fifth wing, three stories in height, contains a number of small rooms, which will be of service for special pieces of work; the other four wings give the main laboratory accommodation. Two of these each contain two large rooms about 35 feet long by 25 broad—one of which has been subdivided—the other two are of about half the size, and contain one room each of the above dimensions. All these rooms are on the ground; they have excellent floors, and are in the main well lighted; in each wing there is considerable space between the ceiling and the roof; in two of the wings this space contains attic rooms. Thus omitting the room which has been subdivided, there are five large laboratories on the ground floor in the wings, and two in the central block. There are, in addition, a number of while some existing buildings will be utilised for a battery-room, a drawing office, and for other purposes. To the north of these buildings stand, at a distance of about 100 yards, the house. To minimise the risk of vibrations from the engine being felt to enter the physical laboratory, a Parson's Turbo-Generator will be used to provide light and power, and the latter will be transmitted electrically. The engineering laboratory will have a traversing crane fitted, and will contain the main workshop of the Institution.

The grounds of Bushy House, under the direct control of the Royal Society, are nearly twenty-five acres in extent; it will be possible, therefore, to put up, if required, isolated buildings for special experiments; the use, for example, of a large testing machine in the engineering laboratory might shake the physics laboratory, and would certainly disturb many of the experiments in the engineering laboratory itself. At present the funds available are insufficient to permit of the purchase of such a machine; if it is found that one is wanted, and money were forthcoming, the necessary buildings could be erected in another portion of the grounds.

[*Photo. by Lascelles London.*

FIG. 1.—National Physical Laboratory. Bushy House from the East.

other smaller rooms, and at the back various kitchen offices, which can easily be rendered most useful.

This general plan has some distinct advantages; it is not unlike Principal Lodge's ideal laboratory, a central block to serve as a museum, entrance-hall, offices, &c., with four wings assigned to definite branches of the work. Each wing is isolated from the others, and the chances of an observer being affected by his colleague in the next room are reduced. At the same time the difficulty of supervision is increased, while the fact that the levels are different in the wings and in the main building renders the transport of apparatus a matter of some trouble.

Our illustrations give a view of Bushy House from the east and a plan of the ground-floor.

This building will serve then for the more delicate physical measurements. For the engineering work a new laboratory is to be built; this will be 80 feet by 50 feet in area, with a weaving-shed roof lighted from the north and arranged so as to be easily capable of extension. Adjacent to it will be an engine and dynamo-room,

Together with their report the Committee presented a scheme of work for the current year.

The experimental work, which it is possible to do with the appliances at the Kew Observatory, is small; still it is hoped to increase the testing work which goes on there. Arrangements are being made for examining chemical measuring apparatus, flasks, burettes, and the like, and also, at the request of the Board of Agriculture, the bottles used in the Babcock milk test. An air thermometer, given by Sir A. Noble, has been erected, and will be in use as a standard of temperature up to about 400° C., while preparations are being made for the construction of mercury standards of resistance.

As to work for the future, which is to be taken up when Bushy House is occupied, the subject to which three, at least, of the Advisory Committees gave the first place was the connection between the magnetic quality and the physical, chemical and electrical properties of iron and its alloys, with a view specially to the determination of the conditions for low hysteresis and non-agency

properties. This problem, then, will, as soon as possible, be taken in hand.

Another important task is the testing of steam gauges, indicator springs and the like; for this purpose a mercury pressure gauge will be provided in the physics building to measure pressures up to twenty atmospheres —the height of the building will not allow more to be measured directly—together with an arrangement for multiplying in a known ratio the pressure measured directly.

Again, gauges of all kinds used in engineering practice will be tested, including the standard screws which the Small Screw Committee of the British Association hope to issue. Another problem which calls for early attention is that of wind pressure on surfaces.

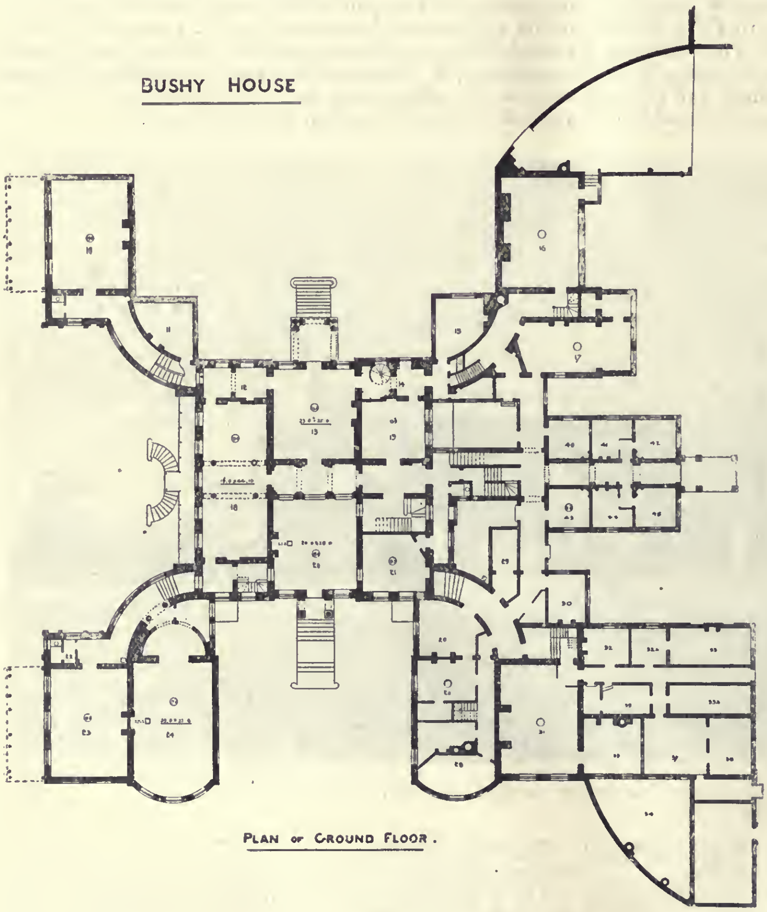

FIG. 2.

In electricity there is ample scope for work. The magnetic testing of iron for commercial use will be undertaken at once, and there are many forms of apparatus which do not come under the direct cognisance of the Board of Trade Electrical Department for which it is desirable to have some recognised test—*e.g.* condensers, special forms of cells, resistance boxes as distinct from standard coils and the like. A valuable list of measurements, by which the work of the Board of Trade Laboratory would be supplemented and assisted, has been submitted to the committee by Mr. Trotter.

Optical and thermometric testing is now carried out to a large extent at Kew Observatory, but both these branches of the work can be extended; the question of the measurement of very high and of very low temperatures is becoming more important each day. In the Optical Department photographic lenses are now tested by eye observations only. It is proposed to establish a photographic test, and to include microscope and other lenses.

It will be seen thus that there is a full programme of work before the staff of the laboratory; the Committee are anxious to keep in the closest touch with trade and industry, and the Director will welcome any suggestions to secure this end. The laboratory has been established to deal with physical problems bearing on manufacture and commerce; it can hope to succeed only through the cordial co-operation of the men who know what those problems are, and who can indicate the lines along which the necessary investigations should proceed; with their assistance it may soon do a national work.

THE PRESENT CONDITION OF THE INDIGO INDUSTRY.

FOR some time past letters on the subject of artificial *versus* natural indigo have been appearing in the *Times*. One by L. J. Harington, which appeared at the end of last month, is of considerable interest, since he writes as a planter of nineteen years' experience. He considers that the days of natural indigo are not numbered, and that the Government of India are not likely to take the advice of Dr. Brunck (NATURE, p. 111) and endeavour to grow food stuffs in place of cultivating indigo. He further remarks that "there is so little to choose between artificial and natural indigo that the whole thing is a matter of price, and the victory must go to the one who can afford to sell cheapest." He then goes on to say: "Indigo had always paid, at times well, at other times fairly so, and planters were content to grow and manufacture indigo exactly as their predecessors had done. Then in 1897 the Badische discovery came like a bolt from the blue." This is a rather remarkable admission. Here were men manufacturing indigo, and they had evidently not taken the trouble to ascertain what was being done in the scientific world and by other manufacturers. Were they not aware that so far back as 1880 indigo had been synthetically prepared, and that numerous patents had been taken out? Certainly the processes had not been commercially successful; but surely they should have taken warning, and endeavoured to improve their product and to manufacture it more cheaply.

Mr. Harington says that after the "bolt from the blue" in 1897 the price of indigo steadily fell until 1899, when, owing to the bad season, one of the finest crops ever seen in Behar was ruined and the price rose nearly 25 per cent. This naturally gave the producers of artificial indigo their chance, and they were able to offer their product at prices slightly lower than those ruling for the natural article. According to Mr. Harington, when synthetic indigo was first placed on the market the average cost of manufacturing Behar indigo was 170 rupees per maund, but that now, owing to more careful working and by sowing only on good lands, it

can be produced for 100 rupees, and he hopes that by engaging, not one chemist, but a dozen, the "cost of making indigo will soon be reduced to a level at which it will be quite impossible for synthetic to compete." Mr. Harington says, however, that the Behar planters cannot afford to spend more on experiments than they are now doing, and he appeals to the Indian Government to give a grant of at least 5000*l.* for five years. It is certainly refreshing when an indigo planter calls, not for one experienced chemist, but for a dozen. It is, unfortunately, more usual for manufacturers to sneer at chemists, saying that they only waste material in experimenting. Do they imagine that experiments which are carried out by chemists on the Continent and in America, and which enable these countries to undersell us, cost nothing?

If our manufacturers employed capable chemists and gave them a free hand, instead of employing what one may perhaps be allowed to term *glorified bottle washers*, there is very little doubt but that they would find experimenting does pay.

If it is true that, owing to bad seasons in India, the indigo producers cannot afford to pay for expert advice, then, owing to the enormous interests which are involved and the danger of delay, surely the Indian Government will not refuse its aid. It must, however, be remembered that Government cannot aid every industry.

It has already been stated in a previous article that Sir William Hudson had applied to the Indian Government for a loan to help the indigo planters to reintroduce the cultivation of the sugar-cane, as an auxiliary to the production of the dye-stuff. The Government of India thereupon appointed Mr. O'Conor, head of the Statistical Department, to report on the proposed scheme of rotating sugar with indigo crops.

Before 1840 sugar was cultivated and manufactured in Behar, but the methods employed were of the crudest, and transport was bad and expensive, therefore the production of sugar gradually died out, and many of the sugar planters turned to the manufacture of indigo. Since 1840 railways and good roads have been introduced. By careful selection and cultivation a better quality of cane-seed is now obtainable. Further, improved modern machinery and methods enable the sugar grower to obtain a much enhanced yield of a good class of sugar. The committee appointed to inquire into the possibility of the cultivation of sugar by indigo planters have nearly finished their work, and it is understood they are of the opinion that the cultivation should yield a handsome return to the planters in Behar, "*if its cultivation, manufacture and distribution are conducted on business principles.*" I might also add on *scientific* principles, and let them employ chemists who are able to do more than simply determine the strength of the sugar by means of a saccharometer. It is to be hoped that the indigo planters, if the cultivation of sugar is introduced, will not again settle down into lethargic coma with the idea that all is now well. They may be absolutely certain that any advantage which they obtain will only add to the energy with which the German men of science will attack the problem. F. MOLLWO PERKIN.

THE ROYAL INDIAN ENGINEERING COLLEGE.

ALL the members of the teaching staff at Coopers Hill must be gratified at the expression of public opinion in support of the cause of the seven gentlemen who have received notice of dismissal. Since our remarks upon the matter were written last week, leaders and letters have appeared in the *Times*, *Daily News* and other newspapers, expressing astonishment at the condition of things which permits distinguished men of science to be treated with indignity, and demanding that an inquiry shall be made not only into the present case of injustice, but also into the whole system which renders it possible for scientific service to be belittled by the action of an official unable to appreciate its value.

Testimonies to the importance and efficiency of the work done by the scientific staff at Coopers Hill have been given by men whose opinions carry weight with the public as well as in the world of science. As mentioned last week, Lord Kelvin has directed attention to the valuable work done at the College, and has given his great influence to the cause of the teaching staff. Prof. J. A. Ewing, F.R.S., professor of mechanism and applied mechanics in the University of Cambridge, has since come forward to add his testimony to that of Lord Kelvin and others. The following words of Prof. Ewing's are of particular value in enabling people to appreciate the gravity of the case.

"To suggest that the dismissal of men like Prof. McLeod and Prof. Hearson can make for efficiency is preposterous. I know nothing of the finances or of the administration of Coopers Hill, but I do know something of its teachers and of their teaching. I have examined Prof. Hearson's students at Coopers Hill, and have had the advantage of co-operating with him as examiner in the Mechanical Sciences Tripos at Cambridge. The pages of the Royal Society's *Philosophical Transactions* bear witness to his originality as a contributor to engineering science. Those who know, as I do, what fulness of knowledge and what infinite patience he brings to bear upon his teaching are not surprised that he teaches with success. One feels that to praise him is an impertinence, but when he and his colleagues are treated in this incredible fashion those who know their merits should speak out."

So far as personal qualifications are concerned, therefore, the dismissed members of the staff are perfectly competent to perform their duties; and the results obtained prove that the teaching has been done in a most efficient manner. But a much larger question is at issue. A writer, who signs himself "J. P.," in the *Times* substantiates this remark with a statement of personal experience.

"For upwards of a quarter of a century," he says, "Coopers Hill has supplied the Indian Public Works Department, and for more than half that time the Indian Forest Department, with a body of recruits whose efficiency has been the admiration of all those whose position and experience render them competent to judge the question, men with whom I for one (and I am sure that I express the opinion of all the older members of the Public Works Department) feel it an honour to be associated."

If it were worth while, evidence to this effect could be considerably multiplied, but no useful purpose would be served by doing so. Every one who has followed the expressions in the public Press since the letter from Colonel Ottley was published, is convinced of the abilities of the gentlemen who have been dismissed, and the efficiency of the College.

This efficiency has been attained in spite of circumstances tending to discourage the teaching staff. It is nothing short of a scandal that capable men like those giving instruction at Coopers Hill should be controlled as if they were orderly-room clerks or petty assistants in a private school, with a Mr. Squeers as their over-lord. The only reasonable way to carry on the work of an institution for higher education is to let the teaching staff be largely responsible for the arrangement of courses of studies as well as for the actual instruction, but this does not appear to be the method followed at Coopers Hill; for the present deplorable state of affairs could not have arisen if the views of the staff as to the reorganisation of studies had been obtained. "J. P." expresses this view in the following extract from his letter:—

"One of the reasons why it has been so successful is that former presidents have looked upon the college not as a field for the display of their own vanity, or for trying experiments

to prove their own powers of organisation, but as an institution of lofty traditions and high standards, the maintenance of which it has been their study to secure by constant watchfulness and such gradual changes as experience has shown to be necessary, rather than by hasty and sudden departure from the practice of the past. They have also recognised that the power of control vested in them is not one to be hastily and capriciously brought to bear upon every detail of the life of the college; that the members of the teaching staff are their colleagues and friends, men of honour, integrity and experience, whose advice and opinions on matters connected with their work should be sought for with eagerness and listened to with respect, even if they cannot ultimately accept them.

"When an institution has been worked under a particular system with conspicuous success for eight-and-twenty years, and in the twenty-ninth year we find, in place of order, chaos, in place of friendship and *esprit de corps* of the best kind, distrust and recrimination, when half the staff are dismissed with the notice that would be given to a coachman, and the other half are in the dark as to what their future duties are to be, when the students are on the verge of mutiny, and threats of dismissal are daily occurrences—it is not 'the system' which is to blame."

The president of the College apparently rules as an autocrat, and the members of the teaching staff have to do as he directs them, whatever their own opinions as to the scheme of work or value of subjects may be. The Board of Visitors has a conference with the president for an hour or so once a year, and his views or recommendations are naturally adopted. The board does not come into contact with the teaching staff, and the members are, therefore, unable to understand the conditions under which the work of the College is carried on. It is stated, indeed, that the Board of Visitors imagined the revised curriculum submitted to have been considered by the teaching staff, whereas the staff were not consulted.

We notice in the *Times* the statement that the Secretary of State for India has refused to grant the inquiry asked for, but it is to be hoped the matter will not be allowed to rest here. A strong deputation must be organised to present the memorial which we understand has been prepared, begging for an inquiry into the case, and directing attention to the position of the teaching staff in relation to the educational policy of the College. Unless there is a reformation, the case of the members of the staff left will be even worse than that of those who have been ordered to retire in such an inconsiderate way.

Among the signatures already appended to the memorial are those of—Lord Kelvin, Lord Lister, Lord Rayleigh, Sir William Huggins, Sir Frederick Abel, Sir Frederick Bramwell, Sir William Crookes, Sir Archibald Geikie, Sir Norman Lockyer, Sir Andrew Noble, Sir Henry Roscoe, Prof. Armstrong, Mr. W. H. M. Christie, Prof. Dewar, Prof. Ewing, Mr. R. T. Glazebrook, Mr. W. N. Shaw, Prof. J. J. Thomson, Prof. Marshall Ward, and of some seventy other Fellows of the Royal Society. Professors and teachers at all the educational centres in the country are sending in their names and testifying to the widespread indignation at the action of the India Office.

H. W. CHISHOLM.

MR. H. W. CHISHOLM, late Warden of the Standards, Board of Trade, died in his ninety-second year on January 16. He was formerly chief clerk of the office of the Comptroller General of the Exchequer, and on the abolition of that office in 1866 he was appointed to take charge of the old Department of Weights and Measures. In 1867 a new Standards Act was passed, by which all powers and duties of the Treasury and Exchequer were transferred to the Standards Department of the Board of Trade, and Mr. Chisholm was made the chief of the department with a salary of 1000*l.* per annum. In 1868, mainly on Mr. Chisholm's representations, a Royal Commission on Standards was appointed, on which he became an active member. The Commission included also the late Prof. W. H. Miller, Sir George Airy and General Sabine, eminent men of science, by whose efforts the Standards Department was raised to a prominent scientific position, furnished with proper standards of length, mass, capacity and cubic measurement, and with instruments essential for verifications for scientific purposes.

Mr. Chisholm held the appointment of Warden of the Standards until 1877, when he retired after fifty-three years of public service. With his retirement the title of Warden of the Standards was dropped, the duties then being undertaken by a superintendent of the Standards Department.

Mr. Chisholm issued an annual report during the ten years he held office, which was always full of information of great interest and public use, and in which metrological researches were dealt with in an exhaustive manner. For instance, amongst the subjects which his printed reports dealt with we find, besides the ordinary work of testing and comparing, standards of measure, &c., investigations as to the expansion of metals, density of water, effects of atmospheric pressure with reference to the measurement of gas, calculation of probable errors of observation in micrometric work, &c.

Mr. Chisholm took a prominent part in the early work of the Bureau international des Poids et Mesures at Paris, which was established under a Metric Convention; and he represented Great Britain at a diplomatic conference at Paris in 1875. In 1877 he published a book relating to the history, &c., of the standards, entitled "Weighing and Measuring" (Macmillan).

With Mr. Chisholm an important link has passed away between the old and the new civil servants, and all who had the pleasure of knowing him well will remember for many years his varied abilities, cheerful disposition, and his desire to help others.

NOTES.

IN consequence of the death of the Queen, all the lectures at the Royal Institution have been abandoned until further notice.

WE have received information from Cairo that the time ball at Port Said is dropped daily at 12 noon (30° meridian time) by direct automatic signal from Abbassia Observatory. Omdurman receives the same signal, and from about the middle of February the time ball at Alexandria will be similarly controlled. Arrangements have been made by which a daily weather telegram at 8 a.m. is exchanged between Alexandria and Malta, Brindisi, Trieste, Athens and Beirut. The information so received is posted outside the port offices at Alexandria and Pord Said daily for the use of shipping.

PROF. R. BLANCHARD has resigned his office of general secretary of the Zoological Society of France, after twenty-three years of service. The Society has decided to present him with a medal in commemoration of his work.

WE regret to see in the *Times* the announcement of the deaths of Dr. Danckelmann and M. Gramme. Dr. Danckelmann was director of the Prussian Royal Academy of Forestry at Eberswalde. He rendered great services to the science and art of forestry in Prussia, and was one of the first to advocate effectively the training of foresters in special colleges. He took a leading part in the teaching at Eberswalde and was the author of many interesting works on forestry. M. Gramme will be remembered by his inventions in connection with dynamos and electric batteries. For his dynamo he received 20,000 francs from the French Government and the Volta prize of 20,000 francs from the Academy of Sciences.

THE annual general meeting of the Geologists' Association will be held at University College on Friday, February 1. The president, Mr. W. Whitaker, F.R.S., will deliver an address entitled "Twelve Years of London Geology."

THE thirty-first course of lectures and demonstrations for sanitary officers will commence at the Sanitary Institute on February 1. There will be four lectures on elementary physics and chemistry in relation to water, soil, air, ventilation and meteorology; twenty-one lectures on public health statutes, the practical duties of a sanitary inspector, municipal hygiene, and building construction; and seven lectures on meat and food inspection.

CAPTAIN J. C. BERNIER, of Quebec, is in England, and has described to a Reuter's representative and the Royal Colonial Institute his plans for an Arctic expedition, which have received the approval of the Quebec Geograpical Society. His first plan is to enter Bering Strait during July, and, following the Siberian coast, the ice would be entered between 170 and 165 degrees, as far east as its state would permit, pushing north in August and September, and dropping buoys at intervals to test the ice drift. Monthly, as the wind suited, small balloons would be despatched with records, each balloon having a copy of the previous records. Photography would be largely employed, kites being used for long-distance photographs. With suitable appliances, it was known that a long distance could be run on the packed ice during the proper season. In the second spring and summer it is suggested that two routes be taken—one in a north-east, the other in a south-west direction—with stations at intervals, keeping communication with the ship by wireless telegraphy and gun signals. The routes would be marked at mile intervals by hollow staves, the hollows being filled with condensed provisions and records, and each staff would be numbered. When in the neighbourhood of the Pole, the north-eastern route would be extended to more stations, always in communication with the ship. These plans are to be laid before the Canadian Government.

THE annual report of the Council of the Institution of Mechanical Engineers was read at the annual meeting on Friday last. We learn from it that the award of the Willans premium has been for the first time in the gift of the Council, and, from the papers read before the Institution since the foundation of the fund in January 1895, they have selected that read in April 1895 by Captain H. Raill Sankey, on "Governing of Steam-Engines by Throttling and by Variable Expansion," as the most suitable for the award. Sir William Roberts-Austen is still at work upon the sixth report to the alloys research committee, dealing mainly with the effect of annealing and tempering on the properties of steel. Prof. F. W. Burstall expects to complete his second report to the gas-engine research committee in the course of a few weeks. Progress has been made in the experiments on the value of the steam-jacket, by Prof. T. Hudson Beare. Prof. D. S. Capper has made a first series of tests on the compound steam-jacketed engine at King's College with different steam-pressures and speeds, working single-cylinder, non-condensing. The results have been worked out, and are expected to be ready shortly. The Council have consented to take charge of the mechanical section of the Glasgow International Engineering Congress, the meetings of which will be held during the first week of September. They have also decided that these arrangements should not interfere with the ordinary summer meeting of the Institution, which will be held during the last week in July at Barrow-in-Furness. Mr. W. H. Maw has been elected to succeed Sir W. H. White as president of the Institution.

THE experiments made with a view to using liquid air as one of the constituents of an explosive are described by Mr. A. Larsen in a paper (No. 786) received from the Institution of Mining Engineers. The cartridges used for blasting trials in the Simplon tunnel consisted of a wrapper filled with a carbonaceous material, such, for instance, as a mixture of equal parts of paraffin and of charcoal, and dipped bodily in liquid air until completely soaked. The cartridges were kept in liquid air at the working face of the rock until required for use, when they were put quickly in the shot-holes and detonated with a small guncotton primer and detonator. The life of such a cartridge is, unfortunately, very short after the cartridge has been removed from the liquid air. A cartridge eight inches in length and three inches in diameter has to be fired within fifteen minutes after being taken out of the liquid to avoid a miss-fire. On this account the Simplon trials were discontinued; nevertheless, Mr. Larsen says that much attention is still being devoted to the matter in Germany, where investigations are being carried on in three different centres, one of them being the largest explosives works on the Continent, namely, the carbonite factory at Schlebusch.

A REPORT of the Government of India shows that during the year 1899 the number of deaths among human beings attributed to wild animals was 2966. Tigers caused the death of 899, wolves of 338, and leopards of 327 human beings, while bears, elephants, hyenas, jackals and crocodiles were accountable for a large proportion of the remainder. The loss of human life from snakes reached the high total of 24,621, a greater mortality than in any of the four preceding years. Nearly half the deaths occurred in Bengal, while the North-Western Provinces and Oudh came next with nearly one-fourth of the total. In Bengal the relatively high mortality is attributed to floods, which drove the snakes to the high lands on which village homesteads are built. As will be observed, snakes are more destructive of human life than are the wild animals, but the reverse is true of the destruction of cattle. In 1899 no fewer than 89,238 cattle were destroyed by wild animals, and 9449 by snakes.

THE U.S. Weather Bureau has published a very useful and comprehensive treatise on West Indian hurricanes, by Prof. E. B. Garriott (*Bulletin*, No. 232). The chief of the Weather Bureau points out that the paper in question reviews the writings of the more prominent meteorologists of the past century, so far as they refer to the tropical storms of the North Atlantic, and that it graphically illustrates and describes the more important hurricanes that have occurred during the last twenty-five years. A table is given (partly taken from that by Señor A. Poey) of the chronological occurrence of West Indian hurricanes since 1493. This list shows that while storms occurred in every month, the great majority took place between July and October. During the principal hurricane months the storms generally recurved east of the Gulf of Mexico, the mean track being farther west in September, when it approached very near the East Florida coast. But the tracks from 1878 to 1900, which are laid down on charts, show that during the principal hurricane months recurvature may occur from far to the eastward of the Bahamas to the west coast of the Gulf of Mexico.

WE have received from the meteorological reporter for Western India a copy of his "Brief Sketch of the Meteorology of the Bombay Presidency for 1899–1900." The meteorology of the year is of more than usual interest, owing to the almost unprecedented failure of the south-west monsoon rains over a large region, and the consequent partial or total failure of crops and water supply. From a statement showing the most severe droughts and famines of the last 150 years, and the areas affected, it appears that the drought of 1899 and famine of 1899–1900 extended over a very much larger area than that of

previous years. The failure of the rainfall was chiefly due to the weakness of the Arabian Sea monsoon current, which generally brings heavy rainfall in July and August. Another feature of the year was the abnormal high barometric pressure which obtained during the monsoon months. The observations of many years show that such conditions are attended by a general decrease in the rainfall; in the years 1876, 1896 and 1899, the most recent years of drought, the average pressures during the monsoon months were ·015, ·012 and ·054 inch, respectively, above the normal. It is noteworthy that in South Africa 1899 appears to have been a year of excessive rainfall.

THE *Electro-Chemist and Metallurgist* has made its appearance, and we trust it has come to stay; for it should be the means of directing attention to a very promising branch of applied electricity, and of advancing a knowledge of electrochemistry. Germany has two periodicals devoted exclusively to electro-chemistry, and is in advance of us, not only in this respect, but also in the provision made for the study and use of electro-chemical processes. The first article in the new periodical, on "Recent Progress in Electro-chemistry," shows that England's share in the advances of recent years is not in proportion to her position in science and industry. It is stated that the total horse-power expended in electro-chemical industries is about 400,000, "equivalent to a total yearly production valued at over 30,000,000*l.*, of which the United States contributes between 60 and 70 per cent., Germany and France about 10 per cent. each, Switzerland about 2 per cent., and England not more than 1½ per cent." Among the subjects of other articles in the journal are little-known carbides, borides and silicides; electro-chemistry at the Paris Exhibition; deposition of metals from mixed electrolytes; and the present and future of accumulators. In addition, there are several pages of abstracts from foreign contemporary journals, and from recent patent specifications. The journal will be published monthly, and should have a wide sphere of influence in the electrochemical and metallurgical professions in England.

TO the December issue of the *American Naturalist*, Prof. H. F. Osborn contributes the third instalment of his investigations into the origin of the Mammalia, taking as his text the evolution of the occipital condyles of the skull. It has been very generally supposed that the paired mammalian condyles are inherited directly from those of the Amphibia. This, however, the author considers to be a misconception; his objection being largely based on the circumstance that in the Amphibia the condyles are derived exclusively from the exoccipitals, without any trace of a basioccipital element. On the other hand, in many mammals, especially Echidna, the basioccipital forms the basal portion of the condyles, or, at all events, the intercondylar interval; and it is shown by figures how such condyles are traceable to the tripartite condyle of reptiles by the gradual abortion of the median basal element. In fact, one anomodont reptile (*Cynognathus*) has actually attained the dicondylar type by means of this elimination.

IN the same journal, Prof. C. S. Minot, preparatory to the publication of a text-book on the subject, calls attention to his own method of teaching mammalian embryology. He recommends, first, the study of pig embryos of from 9 to 12 mm. in length, and, secondly, larger examples of the same, after which the embryo chicken should be taken in hand to illustrate the germ-layers. Then should come the study of the fœtal envelopes, including the human placenta, and finally an investigation of the genital elements, segmentation, &c. Before calling attention to the importance of the "cervical bend" as distinctive of mammalian embryos, Prof. Minot takes occasion to refer to the superiority of the German system of "black line" wood-engraving for the purpose of illustrating embryological studies, the cheapness of German work being likewise an important factor.

DR. J. BEARD, of Edinburgh, has recently contributed to the current volume (xviii.) of the *Anatomischer Anzeiger* two suggestive papers bearing on the fate and function of that physiological puzzle, the thymus gland. In the former of these (Nos. 15 and 16) he identifies a certain structure in the spiracle of the ray (Raia) as the representative of the thymus. In the latter (Nos. 22 and 23) he arrives at the conclusion that the thymus is the source of all the "leucocytes" of all true vertebrated animals, and hence that it is the origin of all the lymphoid structures of the body. The latter statement, he observes, throws light upon the fact that the thymus is an example of an organ which, after being functional in early life, gradually atrophies. "This is only certainly known to happen in mammals, and from it the inference is drawn that in later life the organ ceases to exist. It no more ceases to exist than would the Anglo-Saxon race disappear were the British Isles to sink beneath the waves."

AN interesting description of the ravages of white ants, or termites, in Rhodesia is furnished by the Rev. A. Lebœuf to the *Zambesi Mission Record* for January. The special interest of the contribution centres in the account of the damage done to property by white ants in Rhodesia, which seems to be even greater than in India. It is no uncommon thing, says the writer, for the colonist, on returning from his day's labour, to find the coat he left hanging on a nail of his cottage wall and the books on the table absolutely destroyed by these tiny marauders. Nor is this all. "On awaking next morning," writes Mr. Lebœuf, "you are astonished to see in the dim light a cone-shaped object rising from the brick floor a short distance from your bed, with two holes on the top like the crater of a miniature volcano. Upon closer examination you discover that the holes have just the size and shape of the inside of your boots, which you incautiously left on the brick floor the night before. They have given form and proportion to an ant heap, and nothing is left of them except the nails, eyelets and, maybe, part of the heels." And as the same dismal story—with variations—has to be told about every other article of apparel and all perishable objects, it must be admitted that there are drawbacks to the lot of a settler in Rhodesia.

THE *Agricultural Students' Gazette* for December contains an appreciative article on the late Sir John Bennet Lawes, who always took a kindly interest in the success of the college at Cirencester.

THE West of Scotland Agricultural College has sent out an interesting report on a series of experiments on the growth of oats in the season of 1899. A considerable number of the leading varieties were grown under equal conditions in various districts of Scotland; their yield, as regards grain, straw, meal and husk, being subsequently determined. While the results of a single season—and that an altogether abnormal one—cannot be accepted as final, enough is shown to justify further attention being bestowed on the matter. Greater care should, however, be given in future to safe-guarding the crops against the depredations of birds and ground game, for where such pests are admitted to have interfered with growth, a justifiable lack of complete confidence in the results is engendered. On the whole the older varieties have come satisfactorily through the trial, most of the newer sorts being apparently unable to contend successfully with unfavourable conditions of growth. They have, moreover, in some cases an undesirably thick husk, and a correspondingly small kernel. It is to be hoped that Profs. Wright and McAlpine have continued this work during the past season.

THE current number of the *Journal* of the Royal Agricultural Society of England opens with an interesting account, from the pen of Dr. Voelcker, of the results obtained by means of pot-culture at the experimental station at Woburn. He first points out the advantages and the limitations of this form of research, and, like Wagner, of Darmstadt—the originator of this method of cultural experiment—advises that results obtained in pots shall subsequently be tested in the field before they can be confidently recommended to the attention of practical agriculturists. A considerable amount of time has been taken up in testing the effects, on farm crop-plants, of "rare forms of earth," as stipulated by Mr. Hills in his bequest. For the most part the results are not encouraging, though some benefit appears to have resulted from steeping the seeds of cereals in one per cent. solutions of sodium iodide and sodium bromide. Where equal numbers of large and small seeds of wheat and barley were sown in separate pots the yield was, rather unexpectedly, but little affected by the difference in character of the seed. The journal, further, contains some interesting matter on the manufacture and ripening of cheese, by Prof. Reynolds Green, and the valuable report of the Tuberculin Committee.

THE phenomenon of anaërobic life, originally discovered and defined by Pasteur as the existence of living forms in the absence of oxygen, has recently had fresh light thrown upon it by the important researches of Dr. Klett, of Würtemberg. Investigating the problems surrounding the production of spore-less anthrax outside the living body, Dr. Klett has found that if anaërobic conditions for the bacillus are provided by the substitution of nitrogen for air, the growth of the organism is not impaired, and spores develop as freely as under ordinary conditions. If, however, the air be replaced by hydrogen, no spores develop providing the nutritive medium is of a character which permits of the gas being in intimate contact with the culture. It is not, therefore, as supposed by so many investigators, the absence of oxygen which is responsible for the non-production of spores in so-called anaërobic cultivations of anthrax, and this view is also supported by Dr. Weil's experiments on this subject. The mystery of the phenomenon remains still to be solved; meanwhile Dr. Klett has provided a new method for the production of sporeless or asporogène anthrax, and in future it will be advisable to supplement the term anaërobic as applied to a micro-organism by referring to the conditions under which the latter was deprived of air.

THE Zoological-Botanical Society of Vienna will hold its Jubilee meeting on Saturday, March 30. Representatives of the various learned societies with which the Society is in correspondence are invited to the meeting. Information from those intending to be present is requested by the secretaries not later than the middle of February.

TWO communications have reached us from the U.S. Department of Agriculture (Division of Vegetable Physiology and Pathology). The first (*Bulletin* No. 25), by H. Von Schrenk, deals exhaustively with the diseases caused by fungi to which conifers are liable in New England, the symptoms of the disease, the nature of the injury inflicted, and the remedies. The parasitic fungi to which attention is specially directed are *Polyporus Schweinitzii*, *P. pinicola*, *P. sulfureus*, *P. subacidus*, and *Trametes Pini*. The second (*Bulletin* No. 23) describes a disease, known as the spot disease, to which violets grown in America are liable, so virulent that the cultivation of the flower has been abandoned in many parts of the country. It is due to a parasitic fungus, probably of American origin, which the author, Mr. P. H. Dorsett, describes as a new species under the name *Alternaria Violae*. Both papers are very well illustrated.

PROF. STRASBURGER has recently published, in the *Biologischen Centralblatt*, an account of his observations on certain diœcious plants, especially *Melandrium* (*Lychnis dioica*). It is well known that the flowers of this plant are normally unisexual, and that there are also certain correlated differences, *e.g.* the elongation of the internode between the calyx and the corolla, which are likewise characteristic of the staminate flowers. But whereas the stamens are, as a rule, reduced to minute rudiments in the female flowers, they are stimulated to develop, in a normal manner, if the plant happens to become infected with the smut fungus, *Ustilago violacea*. The stamens then grow and advance so far as to form the pollen mother cells in a manner indistinguishable from the process as it occurs in the ordinary staminate flowers; but the fungus, perhaps owing to the abundant supply of available nutrition, then becomes virulent, it kills and consumes the cells, and the anthers are finally filled with the purple spores of the parasite. Nor is this all, for the ovary becomes arrested in its development, the ovules hardly advancing beyond the embryo-sac formation. Moreover, the lengthening of the calyx-corolla internode referred to above also occurs, and these facts have given rise to the mistaken impression that the fungus merely castrated the stamens of a male flower, causing the female organs to develop. This is not the case, for when the male flowers are attacked there is no development of the pistil to be seen. Prof. Strasburger utilises these results as the basis for a treatise on the possibilities of artificially interfering with, or determining, the sex of unisexual organism, and the whole paper is well worth careful reading for the wealth of illustration and critical exposition which it contains. The conclusion is reached that it is not possible, at least in the higher plants and animals, to influence the sex of an individual either by nutrition or by modifying the normal physical environment. The organism in this respect develops on predetermined lines, and only an extraordinary stimulus can surprise the latent potentiality into active development.

A CATALOGUE of the recent marine sponges of Canada and Alaska is contributed by Mr. L. M. Lambe to the *Ottawa Naturalist* (vol. xiv. No. 9).

PROF. E. RICHTER has issued the fifth report on the periodic variations of glaciers (*Archives* des Sc. phys. et nat. Genève, tome x. 1900). References are made to glaciers in Europe, the Polar regions, North America and Asia.

MR. R. E. C. STEARNS publishes some revisions of the nomenclature of Tertiary land shells of the John Day Region in Western North America (*Proc.* Washington Acad. Sc. vol. ii. December 1900). Thus the species named *Helix* (*Aglaia*) *fidelis*, Gray (Stearns) now becomes *Epiphragmophora fidelis antecedens*, Stearns. Truly multiplication becomes vexation in the case of zoological names.

WE have received the annual report of the Geological Commission of the Cape of Good Hope for 1898 (Cape Town, 1900). It is a record of arduous but highly interesting work, hampered to some extent by the want of good maps, but of acknowledged advantage to the inhabitants of Cape Colony. The field-work has been carried out by Messrs. A. W. Rogers and E. H. L. Schwarz under the superintendence of Prof. Corstorphine, and they furnish detailed reports on the districts examined, including the country around Worcester.

THE Geological Survey of India has lately issued several important scientific works. In the Memoirs (vol. xxviii., Part 2) there is an essay on "The Charnockite series, a group of Archæan hypersthenic rocks in Peninsular India," by Mr. Thomas H. Holland. The history of the naming of this series is interesting. A hypersthene-granite, regarded as a new type, and composed of hypersthene, microcline, quartz and accessory iron-ores, was

discovered in 1892; and it was afterwards found that the tombstone of Job Charnock, the founder of Calcutta, was made of the same rock, so the name Charnockite "was suggested for it in honour of the man who was the unconscious means of bringing the first specimen of this interesting rock to the city which ultimately became the capital of India." The members of the Charnockite series are now fully described and illustrated. They are regarded as igneous in origin, and as intrusive in the older schists and gneisses.

IN the "Palæontologia Indica" we have (in series xv., relating to Himalayan fossils, vol. iii. part 2) a monograph on the Trias Brachiopoda and Lamellibranchiata, by Dr. Alexander Bittner, a work translated by Dr. and Mrs. A. H. Foord. About sixty species are described. The genera are all well known and generally distributed in the Alpine Trias. Identical species, however, are only sparingly represented in India. Another monograph (belonging to series ix., Jurassic Fauna of Cutch, vol. ii. part 2) is on corals, by Dr. J. W. Gregory. A magnificent collection of corals from the Peninsula of Cutch was made by Wynne and Fedden and Stoliczka between 1867 and 1872. It was sent to England in 1890 in the hopes that the late Dr. Duncan would undertake the task of description. Owing to failing health he requested Dr. Gregory to carry out the work, and this the latter has now done with conspicuous ability, but not without much anxious consideration. The author was reluctant at first to treat as mere individual variations differences which in the case of the corresponding European corals are regarded as of specific value; but he was driven, and happily so, to this course, as the alternative was the creation of some 3,000 new species or varieties. The bulk of the collection comes from the Putchum Beds (Bathonian) to the north-west of Jumara, and they represent a coral bank rather than a reef. Some corals were obtained from the Chari Beds (Callovian and Oxfordian), and some indicate higher geological horizons. In all seventy-one species are desciibed, and illustrated in a series of excellent plates.

THE question of Hindu castes is treated by Mr. Tribhovandas Mangaldas Nathubhai in the *Journal* of the Anthropological Society of Bombay (vol. v. p. 74). He points out that "the present castes did not strictly adhere to their original distinguishing characteristics," and that the spirit of the original laws "not being rightly understood and followed, they yielded not the advantages intended, and produced evils never contemplated." The author makes some sensible remarks on the remarriage of widows; and with regard to the caste system he advocates, not abolition of caste or the raising of the status of the lower castes, but a reversion to the teaching of the Shastras. In the same number of the journal are some notes on the folklore of the lizard and ominous birds in India.

AN article upon Huxley's life and memoirs appears in the January number of the *Quarterly Review*.

THE meteorological observations made at the Adelaide Observatory and other places in South Australia and the Northern Territory during the year 1897, under the direction of Sir Charles Todd, K.C.M.G., F.R.S., are tabulated and discussed in a volume just published by the Government of South Australia.

A NEW volume of "The Fauna of British India, including Ceylon and Burma," edited by Dr. W. T. Blanford, F.R.S., has been published under the authority of the Secretary of State for India. The author of the volume is Mr. R. I. Pocock, who mentions in the preface that it "contains descriptions of all the species of Arachnida of the orders Scorpiones (scorpions), Uropygi (whip-scorpions), Amblypygi, Solifugæ, and of most of the larger and otherwise conspicuous species of Araneæ (true spiders) known to occur in British India, Burma and Ceylon, together with diagnoses of the genera, families and sub-orders into which they fall."

Popular Astronomy for December 1900 contains the address delivered by Mr. J. A. Brashear at the ceremony of laying the foundation stone of the New Allegheny Observatory at Riverside Park, Allegheny, Pa The history of the institution is reviewed since its incorporation in 1860. Prof. F. L. Wadsworth is the present director of the Observatory. The existing fine equipment is to be considerably augmented, and a special feature is that one department is to be open day and night to the students in the high schools and higher grades of the common schools, and also to citizens—a proposal first suggested by the late Prof. J. E. Keeler, a former director.

MESSRS. ILIFFE, SONS AND STURMEY, LTD., have sent us the fourth edition of Mr. John A. Hodges' "Practical Enlarging." This edition, we find, has not only been thoroughly revised and brought up-to-date, but much additional matter has been included. The worker is provided with a sound and elementary practical handbook, and it is interesting and important to note what the author states in the preface, that "no formula is given, nor any method of working described, which I have not personally thoroughly tested and proved to be trustworthy." With the introduction and general use of hand cameras and lenses giving flat fields, the process of "enlarging" the originals is now so widely adopted that such a serviceable handbook as this will be found most useful.

"WILLING'S PRESS GUIDE" is a handy index to the press of the world. The newspapers and other periodicals included in the lists are classified alphabetically according to title, and are also arranged in other groups according to place of publication and subject. We notice a few curious entries in the various classes of scientific publications of the United Kingdom. Under Astronomy the reports of two observatories are included, and "Astronomical Leaflets" which are not known to us. Under Science also several unimportant publications are named, while others are omitted. For instance, the *Journal* of the City of London College Science Society is given, but the *Philosophical Magazine* does not appear in the list, though it does appear under Philosophy. Reports of local scientific societies are also mentioned under Science and other heads, but the "Year-Book of Scientific Societies" shows that the number of omissions far exceeds that of societies included. If space cannot be found for the reports of all important local societies concerned with natural history and other sciences, it would be better to omit such societies entirely. At present the lists do not give a correct view of the publications of societies of this kind.

SOME interesting measurements of the electromotive force of concentration batteries containing non-aqueous solutions are communicated by L. Kahlenberg in the *Journal of Physical Chemistry* (vol. iv. p. 709). Whereas the E.M.F. of batteries containing aqueous solutions has been shown in very many cases to agree quite well with the potential difference calculated on the basis of Nernst's osmotic theory, the author's experiments indicate that the difference between the observed and calculated electromotive force is very considerable in the case of solutions in non-aqueous solvents. In view of the discrepancies, it is suggested that Nernst's formula should be subjected to a rigid test for the case of non-aqueous solutions.

A COURSE of lectures on electro-chemistry to a large audience is only with great difficulty capable of being illustrated by quantitative experiments. The usual methods of measuring current, resistance, voltage, &c., cannot readily be adapted in a completely satisfactory manner to the exigencies of the lecture-

table. A measuring instrument to remedy the defects associated with the use of the ordinary apparatus is described by Messrs. Miller and Kenrick in the *Journal of Physical Chemistry* (vol. iv. p. 599). Provided with a dial two feet in diameter, and "dead-beat" in its action, the instrument is so arranged that ohms, mhos, volts and amperes can be read off directly, and it can be changed from any one use to any other without delay. A series of fifteen quantitative experiments, chosen so as to illustrate the various principles of electro-chemistry, and which can be shown to a large class by means of the instrument, are described by the authors.

THE additions to the Zoological Society's Gardens during the past week include a Stanley Crane (*Anthropoides paradisea*) from South Africa, presented by Mr. J. E. Matcham; a White Pelican (*Pelecanus onocrotalus*), a Lesser Black-backed Gull (*Larus fuscus*), European; a Yellow Hangnest (*Cassicus persicus*), a Common Boa (*Boa constrictor*) from South America, two Japanese Greenfinches (*Ligurinus sinicus*) from Japan, a Yellow-winged Sugar-bird (*Coereba cyanea*) from South America, a Three-striped Boa (*Lichanura trivigata*), a Chained Snake (*Coluber catenifer*), a —— Snake (*Zamenis taeniatus*), a —— Snake (*Rhinochelus lecontii*) from North America, deposited; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW VARIABLE STARS.—Two more variables are announced in the *Astronomical Journal*, vol. xxi. No. 487, as having been detected by Mr. R. T. A. Innes, at the Cape Observatory.

24.1900. *Arae.* This star is C.P.D. – 49° 10361, and has the position

$$\left.\begin{array}{ll} \text{RA.} = & 17^{\text{h}}\ 49^{\text{m}}\ 32^{\text{s}} \\ \text{Decl.} = & -49^\circ\ 24'{\cdot}9 \end{array}\right\} (1875).$$

The range in magnitude is from 8·9 to 9·75, and the period very short—about 7h 28m. 36s.

25.1900. *Octantis.* This star is No. 9192 in Gillis's Polar Zones, and has the position

$$\begin{array}{ll} \text{R.A.} = & 13^{\text{h}}\ 9^{\text{m}}\ 32^{\text{s}} \\ \text{Decl.} = & -83^\circ\ 34'{\cdot}1 \end{array}$$

The variation in magnitude is from 7·7 to 10·3.

THE ALMUCANTAR.—The Case Observatory, Cleveland, Ohio, has recently been equipped with one of the new type of instruments invented by Dr. S. C. Chandler in 1879, and in the *Astronomical Journal*, vol. xxi. No. 488, Mr. C. S. Howe gives a description of its construction and working, illustrated by photographs of the instrument in position. It is adaptable for all determinations usually made with the transit circle, as time, latitude, right ascensions and declinations, &c., but has several advantages. As the name implies, the instrument is inclined at a fixed elevation, generally equal to the latitude of the station, and being free to move in a horizontal plane, the times of passage over the parallel of altitude are observed in exactly similar manner to meridian transits; in general both transits may be observed, east and west. The advantages claimed are (1) elimination of flexure; (2) elimination of refraction errors depending on zenith distance, leaving only those produced by variations of pressure and temperature; (3) greater precision of fundamental plane of instrument; (4) greater extent of sky available.

The Case almucantar has an object-glass of 6 inches aperture and 60 inches focus, by Brashear, and instead of the telescope being inclined, the light is reflected from a mirror inclined at the proper angle, outside the object-glass.

The whole of this optical apparatus rests on a massive hollow iron ring 57 inches in diameter, which floats in mercury, means being provided for preventing lateral movement. The float, telescope tube and frame weigh about 1800 pounds, and additional weights are provided for adjusting the position of the centre of gravity. Preliminary experiments show that, although the instrument weighs about 2300 pounds, the oscillations after it has been moved die out in slightly over one minute, so that stars can be observed at intervals of three minutes. Another of these instruments, of about the same size as the above, has been erected at the Durham Observatory, and is described by Prof. R. A. Sampson in *Monthly Notices*, vol. lx. pp. 572–579.

THE ETHNOLOGY OF ANCIENT HISTORY DEDUCED FROM RECORDS, MONUMENTS AND COINS.

SERIOUS students of ancient history are fully aware that the narratives which have been preserved by professional historians are usually so eclectic and so meagre in many important details that they require to be largely supplemented by other data before the full significance of the events can be appreciated. The spade of the archæologist has provided innumerable documents of the greatest historical importance which serve to supplement the imperfection of the written record, and the observations and measurements of the physical anthropologist have to be called into evidence as well as the comparative studies of the ethnologist. The historian who ignores archæology, physical anthropology and ethnology deprives himself of the most voluminous of historical documents which lead, when carefully studied, to accurate conclusions. Thus alone can written records be established.

As in the distribution of animals, so in that of man, it is impossible to draw a line of demarcation between Europe and Asia. The pure Northern European type is as distinct as possible from the true Mongol, but there is such a chain of links between these two primary human races that they pass insensibly into one another.

It is now generally admitted that the fair dolichocephalic European race (*Homo Europaeus*, the Northern or Nordic race of some authors, the Aryan of others), stretched in Neolithic times far away into Asia, where they mixed to a variable extent with the Mongols, more so to the eastward, less so to the westward. To portions of this hybrid population have been applied such terms as Allophylian, Turanian, Finno-Turki, Ural-Altaic, Ugro-Altaic, Turko-Tatar, Mongolo-Turkic, Tatar, Turki. Part of this spectrum of mixed peoples was spoken of by ancient historians under the collective name of Scythians, those in Europe being "Aryans," those in the extreme east being largely Mongolised.

A short, dark, brachycephalic race (*Homo Alpinus*, Alpine or Slavo-Celtic race) which wandered into Central France in Neolithic times still persists in a central zone across Europe and into Asia, and there can be little doubt that this element also entered into the population of Western Asia in very early times. But at whatever period they arrived, their descendants can be found amongst the Tadjiks, who are brown brachycephals and quite different from the brachycephals of the yellow race whose point of origin appears to have been towards Tibet, whereas Lapouge and Ujfalvy believe the former to have followed the dolichocephals either from Asia Minor or from Europe.

A third race, of medium stature and dark complexion, is the dolichocephalic Mediterranean group (*Homo Mediterranensis*). This was located in Neolithic times in Western and Southern Europe, Northern Africa, South-Western and Southern Asia. The Dravidian peoples of India do not now concern us, and attention need be drawn only to the Semitic branch of the Mediterranean race, with its various offshoots. It is possible that the rise of Babylonian culture was due, as Keane points out, to the influence of Semites on the indigenous Akkado-Sumerians, who were almost certainly of Finno-Turki origin.

The typical Mongols (*Homo Mongolicus*) are a short, brachycephalic people with a yellowish skin, high cheekbones, very characteristic eyes, lank, black hair on the head, and sparse hair on the face. This race is as purely Asiatic as the negro is African.

The easterly drifting of tall, fair, long-headed peoples speaking dialects of the Aryan group of languages took place, perhaps, about 2000 B.C. The migrants to India had scarcely attained the agricultural phase of culture, and it was not until the conquests of Alexander in 327 B.C. that a true civilisation flourished in the Panjab. The Persian branch advanced much more rapidly, owing to their proximity to the ancient civilisations of Mesopotamia.

Few portions of the world have had so complex a history as the region between the Caspian Sea, the Persian Gulf and the

Himalayas. Streams of migrations have passed through this district, to be caught up into ethnological eddies of which written history is incompetent, by itself, to unravel their intricate movements and blendings.

There is insufficient evidence concerning the physical type or types of the ancient inhabitants of Persia, but one predominant primitive Persian type resembled that of the ancient Hindus, that is, both were long-headed (dolichocephalic), narrow-faced (leptoprosop), with long, thin noses (leptorhine). They also had skulls of but slight height, which were flattened above. In all these respects these Persians of the time of the Achæmenian dynasty resembled the Macedonians of the time of Alexander the Great, and these traits are also represented on Greek coins of the archaic style.

Nearly two hundred years later we again meet with this ancient form of skull, but with slight modifications. On the very beautiful sarcophagus from Sidon is represented a battle (? of Arbele) between Macedonians led by Alexander and Persians under Mazaïos, one of the bravest of the generals of Darius. The main differences between the physical characters of these two nations consist in the head of the Persians being higher and the forehead broader and more vertical than that of the Macedonians. The latter were still characterised by a rather low, flat head, by a rather retreating forehead, and often with prominent supra-ciliary ridges and a well-marked nasal notch. The nose of the Persian is very delicate, but inclined to be arched. Their beautiful eyes are more sunken, but less widely open than those of the Greeks. This superb monument has the inestimable advantage of retaining some of its original coloration, and all the Persians, like the Macedonians, had fair or red hair.

FIG. 1.—Coin of Kadphises II., King of the Kushans; circ. 55 A.D.

On the road from Nineveh to Ecbatana is a most interesting bas-relief, carved on the face of a rock by Darius to commemorate his victories over ten kings and princes, whose portraits are carved, and we have portraits of Semites, Persians, a Mede, Magian, Armenian and Sacian. Behind Darius are represented two Achæmenian Persians, who have a gently-curved cranial vault, a high forehead and a curved nose with a slightly flattened tip. The Magian, who is also a Western Persian, is broad-headed. Dolichocephalism is predominant among the Iranians of this period, and more so among the Eastern Iranians.

A gradual transformation of the Persian type was accomplished in the interval between the downfall of the dynasty of the Achæmenids and the accession of that of the Sassanids (*i.e.* from 328 B.C. to 240 A.D.). The heightening and shortening of the head, amongst other characters that affected the old Iranian type, was due either to the slow substitution by a very brachycephalic pre-existing population or to infiltration from neighbouring countries. Ujfalvy points out that the first of these hypotheses is without any historical foundation, although one would expect to find representatives of the alpine race in Iran at that period, so for the present we must rely on the second alternative. We know, from de Sarzec's excavations, that in Babylon in very remote times there was a mixture of races in which a "Turanian" (Ujfalvy) element was present. This transformation of the Iranian type was helped by the arrival of the Arsacian Parthians, who brought heterogeneous peoples in their train.

A study of the coins of the Parthian kings of the dynasty of the Arsaces also reveals an interesting series of changes. The aryanised tatar type of the first three Arsaces was transformed in the fifth Arsace (Mithridates I., 174–136 B.C.) by a mixture of races of which we have historical evidence, and the skull became elongated and flattened; but we find Mithridates III. (Arsace XI.), 60–56 B.C., with a very short and excessively high skull, which was retained till the end of the dynasty in 227 A.D. Nevertheless, all through the series the face was practically unchanged. The Chinese annalist, Ma-touan-lin, says of the A-si (Parthians), "they marry their elder and younger sisters and even their mothers in the same manner as animals," and Lucian uses an identical phrase.

Other alterations of the physiognomy of the Persians were shown in the very aquiline nose, widely open, sunken and almond-shaped eyes. One very typical characteristic of some of the Sassanidan warriors is the great height of the chin, which is still to be seen among the Hadjemis of Persia.

Among the living Tadjiks and Sarts of Central Asia, as among some stocks of Afghanistan and Western Himalaya, we meet, after some 2000 years, with individuals in whom the facial characteristics, and in some cases their crania, remind one of the portrait heads of the Grecian kings of Bactria and India. The low height of the head among the Afghans, of the natives of Kafiristan and of the Dards, the noble profile of the Pandits of Kashmir, are all heirlooms from a remote time. Also the long, well-formed nose of the Tadjiks, their wavy beard and crafty expression of face recall the typical coins of Persian satraps. These latter, as well as the Arsaces and Sassanids, appear to have been leptoprosopic brachycephals, as the unmixed survivors of the old Persians in India are to this day, for, after twelve centuries of exile, the Parsis of Bombay retain these ancestral traits.

When the portrait coins of the Greek kings of Bactria and India are compared, there is no difficulty in seeing a racial resemblance. In the first Bactrian princes the head is low like that of the typical Macedonians, in the later kings it is higher till eventually the head was almost high. The prominent brow ridge of the Macedonians was very persistent, but it, too, was diminished in the last Bactrian kings; the same held good for the marked notch between the forehead and the nose. The prominent, delicate nose of the early Greco-Bactrian kings became short and thick; these princes were almost exclusively leptorhine, and only, last of all, became mesorhine, but were never platyrhine. The chin of the Greco-Bactrian princes was round and full, but less prominent than in the Macedonians or Syrians. There is a fairly regular gradation among the Greco-Bactrian kings when placed in chronological order, not only in the increase of the height of the head, but also in the decrease of the head-length. The face, too, had a tendency to broaden and shorten, for while leptoprosopy was the rule, chamæprosopy was sporadic and was found in only a few of the later Greco-Bactrian kings. Thus it is evident that the purity of the royal family had been impaired by marriages with women of a different stock.

Allusion has been made to Scythians. Certain Asiastic so-called Scythian nations have played an important part in Western Asia, and we must now see what light monuments and coins can throw on the relationships of these much-discussed peoples. The three Scythian groups known as the Sacæ, Kushans and Epthalites constitute an instructive series.

At the time of the Achæmenian kings, the Sacians (Sakas) occupied all the regions between the lower course of the Silis (Iaxartes) and Lake Balkash. "They," says Herodotus, "were in truth Amyrgian Scythians, but the Persians called them Sacæ, since that is the name which they give to all the Scythians." They were renowned for their bravery and wealth and were recognised tributaries of Persia, and formed the advance guard of the empire against the east, as they were settled in the plains of Turkestan almost at the confines of China.

It would appear that even at this time the Sacæ were a mixed race, as, according to the *Chinese Annals*, the Ssé or Sek (who are identified with the Sacæ) originally inhabited Southern China, but they occupied Sogdiana and Transoxiana at the establishment of the Greco-Bactrian monarchy. Towards 165 B.C. they were dislodged from Sogdiana by the Yué-tchi, who themselves were flying before the Hiung-nu. The Ssé thus dispersed invaded Bactriana, chased in their turn from Bactriana by the Yué-tchi in 120 B.C., the Sacians passed over the Paropamisus (Hindu Kush) and directed their steps towards Southern Afghanistan, occupying Sakastan (Seistan to Arachosia); but a century later they were again harassed by

the Yué-tchi, and a part of them, under Maues, founded a kingdom in the Panjab, where they quickly appropriated Hellenic culture.

The Sakas appear to have been mesaticephalic; the height of the head was rather low, they had straight eyes, a well-formed nose, straight, projecting chin. Ujfalvy remarks that they were not true Scythians, as the Aryan element was outweighed in them by another strain. They are nearer to the typical Parthians, but they are not Tatars.

For two thousand years they have persisted, and in the Balti of to-day Ujfalvy recognises the direct descendants of the Sacæ who, about 90 B.C., invaded India from the north over the Karakoram passes, since, in their physical features, the Balti strikingly resemble the effigies on the rock carvings or on the coins of the kings of the Sacæ. The Pamir countries of the Chugnan and Sirikol still retain Sacian linguistic traces.

The Chinese annalists inform us that the Yué-tchi were located in eastern Turkestan, south of the Celestial Mountains, but being invaded by the Hiung-nu in 201 and 165 B.C., they fled to the west and spread over Sogdiana and Bactria, and dispossessed the Ta-hia (Tadjiks). The annalist thus speaks of the inhabitants of Sogdiana: "Sunken eyes, prominent nose and bushy beard, they excel in trade," just like the living Tadjiks. The primitively nomadic Yué-tchi became sedentary and prosperous in this fertile country. In B.C. 25 Kieu-tsieu, or Kudschula, whom the Greeks called Kadphises, the prince of the Kuei-schuang (Kushan), one of the five tribes of the Yué-tchi, conquered the four other tribes, and, crossing the Hindu Kush, invaded

FIG. 2.—Coin of Jayatu Mihirakula (Mo-hi-lo-kiu-lo of the *Chinese Annals*), last King of the Hûnas; 515–544 A.D.

Kophen (Ki-pin of the *Chinese Annals*), the country of the Asascides, and took possession of Kabul. His son Kadaphes conquered most of Northern India, and this empire lasted till towards the commencement of the fifth century of our era. The *Chinese Annals* tell us that Ki-to-lo (Kidara of the coins) chief of the Great Kushans, yielded before the incursions of the Ephthalites, crossed the Paropamisus and settled at Gandhara, in the Valley of Kabul. Towards 475 A.D. the Ephthalites, or White Huns, conquered Gandhara, forcing the Kushans to retire in the Chitral and up to Kashmir. After the defeat of Mihirakula, the last Huna king, the Kushans preserved their power in these regions till the ninth century of our era.

The Kushans appear to have been a brachycephalic folk with a normal head, high forehead, straight eyes, powerful Semitic nose, full mouth, with a somewhat Semitic cast of countenance, but not in the least Mongolian; there was a full beard. These, according to Ujfalvy, are Tatars and not Mongols, the true Scythians of Hippocrates; with Keane ("Man, Past and Present," p. 322) we may call them a Turki people.

They were a gifted and powerful people, and, in consequence of their high political endowments and their adaptability, they played a predominant part alike in Bactria and North-west India, and to a large extent contributed to the formation of the present racial type north and south of the Hindu Kush, and especially so among the Dards of the Himalayan Valleys.

The Hoa or Ye-tha, originally a small people located to the north of the Great Wall of China, were hunted from their territory by the Yuan-Yuan (or Avars?) and fled to the west, and eventually invaded Transoxiana (425 A.D.) and founded a great empire as far as North-west India. The invasion of Europe by Attila (430 A.D.) and that of the Caucasus by the Kidarite Huns were the result of the same pressure of the Yuan-Yuan.

The Hoa sovereigns had the family name of Yé-ta-i-li-to (Ephthalites) which became the name of the dynasty; this was abridged to Ye-tha. Unlike the Yué-tchi they remained nomads, and, as the Chinese annalists inform us, they practised polyandry. Their empire lasted till 557 A.D., when the Tu-kiu (Turks), profiting by the troubles that had fallen on the Hoa or Huna, seized the government. After their defeat, the Ephthalites did not disappear from Turkestan but retired to the east, while another portion mixed with Kushans south of the Oxus.

The Chinese annalists give various interesting accounts of this people. The Hoa migrated with their flocks and did not live in towns. The women took a good standing; brothers took a wife in common, and the women wore a horn on their headdress for each husband that they had. The people were cruel, valiant and bellicose, and had strict laws.

According to the coins the three kings of the Hûnas (the White Huns or Ephthalites of India) were absolutely hairless, the face has a savage expression, the eyes appear somewhat oblique, the nose is large, jaw powerful, neck fleshy, ears immense and in two of the kings recall the legendary pointed ears of Attila. The occipital region of the head is deficient, the vertex being produced into a truncated cone; this remarkable shape must have been the result of artificial deformation, which greatly exaggerated the natural brachycephaly. They are still Tatars, but approach the Mongolian type.

Polyandry was one of the most characteristic traits of the Hoa, and it still persists in the regions which formerly belonged to their empire. The employment of the horned headdress, which was formerly associated with polyandric practices, still exists among the inhabitants of Kafiristan.

There are still many problems awaiting solution among the intricacies of Asiatic ethnology, and it may be that some of the foregoing conclusions will require emendation, but there can be little doubt that the brilliant researches of C. de Ujfalvy have paved the way to a clearer comprehension of the ethnic affinities of various ancient historical peoples, and his papers in *l'Anthropologie*, Tomes ix. (1898) and xi. (1900), and in the *Archiv für Anthropologie*, Bd. xxvi. (1899), are full of references to the labours of his distinguished fellow-workers, Drouin, Percy Gardner, de Lapouge, Maspero, Rapson, Specht, Stein and others.

ALFRED C. HADDON.

THE CURRENTS IN THE GULF OF ST. LAWRENCE.

THE result of investigation of the currents in the Gulf of St. Lawrence, by the Survey of Tides and Currents, has been issued recently in the form of a pamphlet by the Department of Marine and Fisheries, Canada. These investigations were carried on by Mr. W. Bell Dawson, in charge of this Survey, and were made during the summer months of 1894, 1895 and 1896; and they are supplemented by information collected personally by him from captains of vessels, fishermen and others having a long experience in the Gulf. The examination of the currents was made chiefly along the lines of the leading steamship routes which traverse the Gulf. It thus comprises the more open area of the Gulf rather than the estuaries and straits in which stronger tidal streams occur locally.

In the investigations a steamer was employed. It was anchored in positions carefully selected for the purpose in view. These were in all depths, up to 250 fathoms. The steamer thus served as a fixed point from which to observe the behaviour of the current. The observations of the current and of the force and direction of the wind were continuous day and night. Both the surface current and under-currents were investigated, current-meters, registering electrically, being chiefly used for the purpose. Temperatures and densities were also obtained at all depths, to 200 fathoms; and these indications were found of much assistance in tracing the movement of the water. For fuller descriptions of the methods and appliances employed, some of which were specially adapted to the conditions in the Gulf, the reports of progress issued from year to year by this survey must be referred to.

With regard to the general circulation in the Gulf area, the investigations point to its being, broadly speaking, a movement

of rotation in a left-handed direction. It has been proved that there is no great influx of cold water into the Gulf area through Belle Isle Strait, as was formerly supposed. On the contrary, the chief interchange of water between the Gulf and the ocean is at Cabot Strait, the wider entrance to the Gulf south of Newfoundland.

We cannot enlarge further on these interesting results, as the information as now published is in as concise a form as it can be put. We desire, rather, to draw attention to some points which the investigations themselves emphasise, and which are of general application elsewhere in similar work.

The most important of these is the relation of the under-currents to the current on the surface. These were examined everywhere, to a depth of 30 fathoms at least, as this depth extends almost uninterruptedly over the whole Gulf area. It may be thought, at first sight, that the direction of the under-current has no bearing upon the movement of the water as it affects navigation. In such a region as the Gulf of St. Lawrence, however, the currents in the summer months are all very moderate in their speed, usually ranging from half a knot to one knot per hour; and their direction on the surface is accordingly much influenced by the wind. It was found in these circumstances that the movement of the under-current at 20 or 30 fathoms often showed more definite characteristics; as, for example, a tendency to make constantly in some one direction, or to vary with the tide. The wind is thus a disturbing element; and the under-current, being more in accordance with the normal conditions of the locality, will come up to the surface as soon as the disturbing influences which have been acting on the surface of the water cease to operate.

It may be unfortunate, from the point of view of the navigator, that it is the surface of the water to a depth of 5 or 10 fathoms which is so readily and so frequently disturbed; but, on the other hand, it is clear that it is essential to make a careful investigation of the under-current in order to understand the surface current itself. The study of the under-current is also necessary, if any hope is entertained of arriving at the general circulation in the Gulf or the true relation of its currents to the causes which influence them.

When a period of some length is considered as a whole, and the under-current is also taken into account, it becomes possible to trace the general circulation of the water; which depends upon a greater movement in some dominant direction rather than in other directions, when long averages are taken.

The primary tendency in the surface current is thus to follow the direction which the general circulation has in the locality in question; but this tendency is disturbed and often overcome by the influence of the tide and wind. The tidal influence shows itself chiefly as a veer in the direction of the current, which is either through a limited range or completely around the compass; and it is also probable that the tides themselves are irregular in some localities, owing to interference. When the wind remains in one quarter and has any considerable strength, the drift which it gives to the surface water soon extends to a depth of five fathoms or more, and its influence thus makes itself felt throughout the thickness of the surface layer which affects shipping. As a rule these influences are all acting at the same time; and it is their combined effect which gives rise to the actual behaviour of the surface current.

A knowledge of the general circulation is also important to mariners, as it includes all the more constant currents, and it shows the direction which the surface current tends to take when undisturbed. Although there are few instances of currents in the Gulf area which run steadily enough to be termed constant, we have yet found it possible, from continuous observation or long experience, to arrive at a dominant direction for each locality; or the direction in which the current runs more frequently, and in which, therefore, the water makes on the whole.

With regard, also, to the drift of ice as an indication of the set of the current, a superficial view may readily be taken; but it is here pointed out that to infer correctly the set of the current it is necessary to distinguish between the different kinds of ice met with and their relation to the movement of the surface of the water and to the under-current, respectively.

This is illustrated by the character of the ice met with in the Gulf of St. Lawrence, which is of three kinds:—(1) Berg ice, or true icebergs, found in the vicinity of the straits opening into the ocean. (2) Flat or pan ice, forming fields or in broken pieces, usually not more than 6 feet in thickness, but sometimes as thick as 10 feet. This often jams or shoves along the shore or between islands, and may form masses 20 feet or more in thickness, but it can never be mistaken for berg ice. (3) River ice, from the St. Lawrence River and its estuary. This is also flat ice, but it can be readily distinguished by its appearance from the Gulf ice.

The berg ice, from its great depth in the water, will evidently move with the under-current; and it will not be appreciably affected by the wind. These bergs do not necessarily indicate the direction of the current as affecting shipping, except when the surface current has also the same direction. They show in reality the average direction the current has between the surface and the depth of their draught. This draught is limited to about 30 fathoms by the depth of the Belle Isle Strait. They are thus of much value as an indication of the general movement or circulation of the water.

The relation of the flat ice to the wind and current requires some little consideration. It is, of course, just as true of this ice as of the berg ice, that the greater part is under water; but, as it is almost always in broken pieces, more or less piled and with upturned edges, the wind has a much greater hold upon it, in proportion to its total weight, than on the berg ice. Even when this is allowed for, its depth in the water still gives the current a greater hold upon it than the wind has. For example, if such ice is drifting with a current in a given direction, and the wind is blowing across that direction at right angles, the ice will seldom be set more than two points, or three at the most, off the true direction of the current. When the ice becomes soggy or water-soaked and loses its edges, as it does later in the spring, it will set still more correctly with the current.

When the surface current itself is moving in the direction of long-continued or prevalent winds, as it often does in the Gulf, the flat ice naturally follows the same direction too. Also, in regions where the current is tidal, and the ice in calm weather would drift as far in the one direction with the flood tide as in the other direction with the ebb, the direction in which it makes, on the whole, will depend upon the wind. It is probably for these reasons that it is so often said that the ice drifts with the wind; although this merely expresses the fact, without distinguishing between the relative influence of the wind and the current upon it.

There is also a direct effect which the ice has upon the strength of the current in regions where the direction of the surface drift is under the influence of the wind. The broken and upturned edges of the ice give the wind a much greater hold upon the water than it otherwise would have. Hence during long continued winds the speed of the current is appreciably greater than if the ice were not present. This is undoubtedly the explanation of the common belief which is expressed by saying that "the ice makes its own current." It may be well to recall that the weight of the ice itself is the same as the water which it displaces; and, therefore, the wind has no greater mass to set in motion in producing a surface current than if the ice were to melt and refill the hollow which it makes in the water; yet the presence of the ice gives the wind a better hold than it would have upon the surface of open water free from ice.

There is one condition of the ice which may prevent it from showing correctly the movement of the water. When it is set against an island or headland and packed together for a long distance out, with open water beyond, it may circle round as on a pivot. The outer edge of the pack may thus make a long sweep very different in its path from the true set of the current; and its movements also become irregular, as vessels caught in such ice which are near together in the evening may be ten or fifteen miles apart in the morning.

The influence of rivers flowing into such a land-locked area as the Gulf of St. Lawrence is also discussed, with approximate measures of volume which show how small the volume of even such a river as the St. Lawrence is, relatively to the water in motion in a costal current, which is more nearly comparable with an ocean current.

The probable balance of flow between the Gulf and the ocean is also explained, but measurements of volume of even an approximate kind are wanting to give precision to the results. The importance of such investigations with regard to the movements of fish, which must be influenced by the temperature of density of the water, is also emphasised, in view of the large annual value of the Canadian fisheries.

The further investigation of the currents has been discontinued since 1896 for reasons of economy; but the tides themselves are receiving careful attention, and already trustworthy tide-tables

are issued by the Survey for the more important Atlantic harbours, as well as for the Pacific coast of Canada. The tides are complicated by a great variation in range, and the observations secured will serve also as a basis for future investigation of the currents, many of the strongest of them being tidal in their nature.

THE ABSORPTION SPECTRA OF SALINE SOLUTIONS.

IN the *Scientific Transactions* of the Royal Dublin Society (vol. vii. series ii. pp. 253–312), Prof. W. N. Hartley gives the results of a long series of experimental investigations which he has undertaken to determine the action of heat on the absorption spectra and chemical constitution of saline solutions. After reviewing previous researches by Schœnbein, von Babo, Schiff, Gladstone, Bunsen, Melde, Burger, Vogel, Landauer, Morton, Bolton and Russell, the author gives a description of his mode of experimenting. Wedge-shaped cells containing the liquids under examination were heated in an air-bath with glass sides. The sources of light used were sunlight and an argand burner fed with oxygen.

Then the absorption spectra of solutions of the salts of nickel, copper, cobalt, chromium, uranium, didymium, and various permanganates are described, with details of the measurements, accompanied by drawings from, or reproductions of, the photographed spectra. Much of the discussion is directed to the bearing of the spectral evidence as to the constitution of the solutions, and the following conclusions indicate the results arrived at:—

(1) The absorption spectra of different salts of the same metal, whether solid or in solution, are not identical, even when the spectrum is a marked characteristic of the metal.

(2) When a definite crystalline hydrate dissolves in a solvent which is not water, and is not a dehydrating agent, the molecule of the salt remains intact.

(3) In any series of salts which are anhydrous, and which do not form well-defined crystalline hydrates, the action of heat up to the temperature of 100° C. does not cause any further alteration in their absorption spectra beyond that which is usual with substances which undergo no chemical change by such rise of temperature. The change is usually an increase in the intensity of the absorption, or a slight widening of the absorption bands.

(4) As a rule the crystallised metallic salts, in which water is an integral part of the molecule, dissolve in water at ordinary temperatures without dissociation of the molecule.

(5) Crystallised hydrated salts, dissolved in a minimum of water at 20° C., undergo dissociation by rise of temperature. The extent of the dissociation may proceed as far as complete dehydration of the compound, so that more or less of the anhydrous salt may be formed in the solution.

(6) The most stable compound which can exist in a saturated solution at 16° or 20° C. is not always of the same composition as the crystalline solid at the same temperature, since the solid may undergo partial dissociation from its water of crystallisation when the molecule enters into solution.

(7) Saturated solutions of hygroscopic and deliquescent salts combine with water when diluted to constitute molecules of more complex hydrated compounds in solution.

(8) When a saturated solution of a coloured salt undergoes a great change of colour upon dilution, or any remarkable change in its absorption spectrum due to the same cause, the dilution is always accompanied by considerable evolution of heat.

CONFERENCE OF SCIENCE MASTERS IN PUBLIC SCHOOLS.

WHILE carrying out the important work of spreading scientific instruction in this country, our educationists should make themselves quite sure that the teaching already inaugurated is what it claims to be. Care must be exercised in order that a training in habits of exactness and observation is imparted, as well as an appreciation of the principles of science quite apart from a mere knowledge of facts. By intelligent practical work upon the part of the individual scholar this alone can be attained, and under present circumstances such exercise is difficult to successfully organise in schools.

Expensive laboratories and able masters are of no avail if the necessary conditions be not introduced. The scientific staffs of our large public schools are fully aware of their responsibility to the nation, and what is lacking to enable them to fulfil it. It might, therefore, be thought that they would have been the very first to advocate the necessary changes, but their position, it will be seen, is such a peculiar one that, without strong general feeling behind them, their trouble would be all thrown away.

With the dawn of the new century, however, and in view of the present agitation for an improved system of scientific education, the public school science masters have combined all their energies for the attainment of that end. On January 19, therefore, a conference was held at the rooms of the University of London, and was attended by a thoroughly representative body of men. Sir Henry Roscoe, Vice-Chancellor of the University, and a member of the governing body of Eton College, occupied the chair, and explained the importance of the action taken.

Among the papers read, that by Mr. Oswald H. Latter, of Charterhouse, contained perhaps the most general observations. "Science teaching," he told us, "was first introduced into our public schools as a sop to a growing public opinion, and with a desire to impart a gentlemanly acquaintance with scientific matters. The broad-minded persons who ventured on this new departure imagined, unfortunately, that the admirable mediæval methods of classical and mathematical teaching were equally well suited to the new comer, who, however, had to be content with a very small portion of the temporal possessions of its elder bretheren." Mr. Latter then urged the necessity of a scientific education for future legislators, and our commercial and professional men, and from a national point of view. Form teaching would do much, he considered, to remove the incubus of ignorance and apathy in the coming generation, the following being his recommendations with regard to it:—

(1) Science should be raised to the dignity of a "form subject," and no longer be regarded as a more or less negligeable extra. It should enter for at least one hour into the ordinary work of every day, and claim, at any rate, some portion of the time devoted to preparation. There must be some lopping of the old branches of education if good fruit is to be borne by the engrafted scion.

(2) A classification according to proficiency in science throughout the school.

(3) At least half, and with lower forms more than half, of the allotted hours should be devoted to systematic laboratory work in the elements of physics and chemistry.

(4) The teaching should be continued to the sixth forms instead of being deliberately withheld from them as is so often the case, a distinction which at once narrows the intellectual horizon of the ablest boys in the school, and degrades the subject in the eyes of the remainder.

Mr. E. E. Ashford, of Harrow, would with very good reason teach some physics before chemistry, and, if possible, elementary biology before either, for, he said, let us first use the facts a boy knows to teach the methods of science. All boys, he continued, are acquainted with many bits of natural history, and its general laws were more easily appreciated than the more exact ones of the other sciences. The paper by Mr. Ashford concluded with the following resolution, which found favour with the meeting, viz., that "it is essential that every boy before leaving school should go through a course of practical measurement and experiment involving no previous theoretical knowledge."

Prof. Armstrong, who was present, true to his tenets that academic words should not be used in schools, suggested nature-study in place of biology, but the terms were not recognised as synonymous by several speakers, and so he was somewhat misunderstood. Mr. A. Vassall, in describing the work at Harrow, recommended that the biological lessons should form a continuous course, and it must be remembered that the boys (over fourteen and under sixteen years of age) he teaches are not tiny children for whom unconnected object-lessons are best adapted. The list of lessons given to the conference well illustrated Mr. Vassall's plea for the "judicious skipping" of subjects not quite suitable for introductory work. Mr. Cumming, of Rugby, used, he said, to teach all his boys botany; he owned, however, that he had no qualifications but a love of the subject, and it is not surprising that the other sciences he has since substituted have succeeded better.

Mr. W. D. Eggar, of Eton, pointed out that, owing to external pressure, many public schools had started elementary

physical measurements for small boys, following Board School methods; but that in the latter institutions mathematical and science teaching were continuous, the same master teaching both to the same boys. In public schools the two subjects are kept separate. Much of what is now taught in the laboratory could more usefully be acquired in mathematical class-rooms with all the necessary apparatus. Mathematics would gain enormously, and much valuable science time be saved. Here Mr. Eggar submitted that he was only urging the adoption of practical mathematics which Prof. Perry had long advocated, and without opposition, but also without any visible effect upon the universities, which still, among other things, demanded a modicum of unapplied and undigested algebra. Sir Henry Roscoe bore out what Mr. Eggar had said, and proposed that a meeting of mathematical masters should be held, at which Prof. Perry might possibly convince them. Speaking as a mathematical master, Mr. Hurst, of Eton, cordially agreed with the views of Prof. Perry and Mr. Eggar; he stated, however, that limited time and the requirements of the universities utterly forbade their adoption in his own case. Another point emphasised by Mr. Eggar was that trigonometry mechanics should be introduced at an earlier stage into the teaching of mathematics, and his resolution that "some knowledge of physics should be required of all candidates for a university degree," was carried unanimously.

The universities came in also for a good deal of criticism, among other examining bodies, from Mr. C. Falkner, of Weymouth. Their entrance science scholarships cause boys to specialise while too young, and before they have got a sound foundation upon which to base their education. No college seems to require the same scope of science, and this necessitates what amounts to the private coaching of every boy in the scholarship class of a public school. Mr. Falkner had some very good suggestions to make for the improvement of these and army examinations, and repeated the plea that is now finding much favour, that teachers and examiners should meet and work together.

The paper by Mr. W. H. Lewis, of Exeter, was not discussed, owing to the author's absence. It dealt with the desirability of longer hours and smaller classes, and larger staffs. The difficulty which a "literary" head-master has of realising the peculiarly laborious nature of science teaching where complicated apparatus has to be fitted up was also alluded to.

An interesting survey of the work of school natural history societies was to be found in the address by Mr. A. Vassall, of Harrow, and the discussion upon it. Many advantages were claimed for the subjects involved, from the education of future landowners and travellers as well as for the boys at school. The sectional system, which divides workers up into groups according to their study, was advocated. Compulsory games very often spoiled matters, and individualism, Mr. Vassall very rightly pronounced, was thereby extinguished. Public opinion among the boys and the standing aloof of those with influence, as well as the apathy of many masters, were also cited as obstacles in the way of field work at schools. Nevertheless, quite a number of successful societies at present exist.

Many suggestive methods of actually dividing up the time for teaching were given by various members of the conference; but, one takes it, the most useful purpose it will serve is to bring before head-masters, governors of schools, and examining bodies the results of the experience and the serious recommendations of a body of picked scientific men whose hearts are in their work.

WILFRED MARK WEBB.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE annual meeting of the Association of Technical Institutions will be held on Tuesday, January 29, in the Fishmongers' Hall, London. An address will be given by Sir W. Hart Dyke, Bart., M.P.

WE learn from *Science* that Dr. D. K. Pearsons has given Colorado College 50,000 dollars, promised some time since, and it is reported that he has given Northwestern University 30,000 dollars for the erection of a woman's dormitory, and 200,000 dollars to an educational institution, the name of which is not to be made public during his life time. It is believed that Dr. Pearsons' gifts to educational institutions amount to three million dollars.

SCIENTIFIC SERIAL.

THE *Journal of Botany* for January contains a useful paper by Mr. Arthur Lister on the cultivation of the Mycetozoa from spores. Mr. George Murray and Mr. C. Bucknall contribute a discussion on the question whether the box, *Buxus sempervirens*, is a native of Britain. They conclude that this is unquestionably the case with the locality near Wootton-under-Edge, an adjacent farm having been known as "Boxwell" for at least seven centuries. This increases the probability of the shrub being indigenous also in other localities, including Boxhill, near Dorking. Mr. W. Carruthers and Miss A. Lorrain Smith have a paper on a disease in turnips caused by bacteria. Prof. Potter has named the bacterium *Pseudomonas destructans*.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, January 9.—J. J. H. Teall, F.R.S., President, in the chair.—The geology of South-Central Ceylon, by John Parkinson. In this communication the author endeavours to give some account of the relations between the various granulitic rocks of Ceylon. A series of more or less isolated sections were studied, the rocks in each considered under separate heads, and conclusions put forward relative to the whole.—Note on the occurrence of corundum as a contact-mineral at Pont-Paul, near Morlaix (Finistère), by A. K. Coomára-Swámy. The intrusive granite of Pont-Paul, near Morlaix, contains highly altered fragments of sedimentary rock. The minerals found in them are biotite, muscovite, corundum (first recorded by Prof. Barrois in 1887), plagioclase, andalusite, pyrite, magnetite, sillimanite, green spinel, and zircon.

Mathematical Society, January 10.—Dr. Hobson, F.R.S., President, in the chair.—Prof. Love, F.R.S., made a communication on streaming motions past cylindrical boundaries. Mr. Basset, F.R.S., also spoke on the subject.—Mr. Campbell read a paper entitled "A Proof of the Third Fundamental Theorem in Lie's Theory of Continuous Groups."—The President communicated a paper by Mr. E. W. Barnes on the zeroes of Bessel's functions, and a paper on some cases of the solution of $z^{p^n-1} \equiv 1$, mod. p, by Prof. F. S. Carey.

Zoological Society, January 15.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—Mr. W. E. de Winton exhibited and made remarks on a skin of the large grey Cynictis (*Cynictis selousi*), obtained by Mr. P. C. Reid on the west bank of the Linyanti River, South Africa. The species had been described from a skull only, from Bulawayo, and the skin of the animal had previously been unknown to naturalists.—Mr. O. Thomas exhibited, on behalf of Mr. R. Lydekker, a specimen of the skull of a common fox (*Canis vulpes*) with two upper canines on each side of the jaw.—In describing the collection of fishes brought home from Lakes Tanganyika and Kivu by the Tanganyika Exploring Expedition, under the leadership of Mr. J. E. S. Moore, Mr. G. A. Boulenger pointed out that the study of this important collection did not modify the conclusions embodied in his first report published in 1898. The exploration of Lake Kivu had thrown no light on the origin of the Tanganyikan fauna; the smaller lake proved to be very thinly populated with fishes, which all belonged to widely distributed genera, the species showing a mixture of Nile and Tanganyika elements, with two that might prove to be endemic. The list of the fishes from the two lakes comprised 91 species, 74 of which had been named by the author. The collection now described consisted of examples of 50 species, 26 of which were new to science, 2 being made the types of additional genera of the family *Cichlidae*.—Mr. G. A. Boulenger read a paper on a collection of freshwater fishes made by Dr. W. J. Ansorge in the Niger Delta. The collection was described as one of exceptional interest. One of the two new genera, for which the name *Phractolaemus ansorgii* was proposed, constituted the type of a new family (Phractolæmidæ), intermediate between the Osteoglossidæ and the Clupeidæ. The second new genus, *Polycentropsis*, belonged to the Nandidæ, a family new to Africa; its position was regarded as near the South American *Polycentrus*. A new *Gnathonemus* and three new *Pelmatochromis* were also described.—A communication was read from

the Rev. O. Pickard-Cambridge, F.R.S., containing an account of some new and interesting spiders collected in South Africa by Mr. G. A. K. Marshall, and in the Malay Peninsula and Borneo by Mr. R. Shelford.—Mr. F. E. Beddard, F.R.S., contributed a fourth instalment of his notes on the anatomy of Picarian birds, which contained an account of the skeletons of the ground-hornbills (*Bucorvus cafer* and *B. abyssinicus*) and notes on other species of hornbills.—A communication from Dr. A. G. Butler contained notes on and a list of the butterflies recently collected by Captain H. N. Dunn on the White Nile.—Dr. F. G. Parsons read a paper on the muscles and joints of the giant golden mole (*Chrysochloris trevelyani*), based on an examination of three specimens of this animal. The author found that previous observations, which hıd been made on less material, though mainly correct, were somewhat inaccurate in details.

Entomological Society, January 16.—Annual Meeting. Mr. G. H. Verrall, the President, in the chair.—It was announced that the following had been elected officers for the session 1901–2. President, the Rev. Canon Fowler; Treasurer, Mr. R. McLachlan, F.R.S.; Secretaries, Mr. Herbert Goss and Mr. H. Rowland-Brown.—The President referred to the losses the Society had sustained during the past session by the deaths of Mr. Spence, the Baron de Selys-Longchamps, Mr. Blatch, Major G. Cockle, Mr. P. Crowley, Lord Dormer, Mr. J. H. Leech, Dr. W. H. Lowe, Prof. Joseph Mik, Prof. Emile Blanchard, Dr. Staudinger, and other entomologists. He then delivered an address, in which he dealt chiefly with the abuses and errors which have crept into entomological nomenclature and the reckless manner in which types of various genera are described from single specimens, without careful study of the many forms which a single insect may assume even in a limited locality. He especially deprecated the publication of supposed new species or varieties before their identity had been certainly established, where the object of the author was to claim something more than a contribution to material for determination. In the vexed problem of priority in nomenclature, he expressed himself all in favour of retaining distinctive names only when such names were neither offensive to good sense nor grammar, and cited instances in which a printer's error was still received as orthodox, while the obvious and original name given by the inventor was rigorously discarded. Lastly, in reply to those who have questioned the value of entomology as a science, he mentioned several amusing instances of what an experienced entomologist might do in the way of turning his knowledge to practical account. Commentators on the work of the late Robert Louis Stevenson were unable, but anxious, to discover whether the notes made by him in a certain book were written before or after he had taken up his residence in Samoa. A fly which had been squeezed between the pages settled the question, for Mr. Verrall at once pronounced the remains as those of an insect peculiar to the Polynesian islands.

Institution of Mining and Metallurgy, January 16.—Mr. A. G. Charleton, Vice-President, in the chair.—Notes on mine surveying, by G. A. Troye. In this paper the author refers chiefly to the practice in the Transvaal, and briefly describes the methods employed there. He aims at a high standard in a mine surveyor, who, he thinks, in addition to essential requirements, should be expected to be a competent geologist, with a thorough knowledge of the occurrence of ore deposits, their dislocations, &c. He considers that it is to him the management should appeal in cases of disturbed ground, and he, more than any one, should be able to quickly find a lode lost through displacement, and should be held responsible for the proper development of a mine. Numerous examples explain the different forms of calculation. Stress was laid upon the necessity of checking all survey work most carefully, and to attain this the co-ordinates are always calculated by the author from two sides of a triangle in order to obtain independent results. The traverses are calculated by inverse multiplication of the natural sines and co-sines of the angles of direction or bearings. A strong point is made in the paper of the desirability of having substantial permanent bench-marks both above and below ground, the latter being labelled with a numbered tin ticket. This, the author says, has proved of great advantage to the mine-manager, sampler, &c., and facilitates work of all kinds, especially when a change of staff takes place. Many useful hints are given as to conducting a survey, keeping the field-book and calculating results.—Paper on electro-silvered *versus* plain copper plates, by Edward Halse. In this paper the author deals with the question of the use of electro-silvered plates in gold milling in preference to plain copper plates, and quotes in support of his view various works on the metallurgy of gold. An important question to the millman is whether silvered plates extract more gold from the crushed ore, and the author is convinced from experience that this is the case and that therefore silvered plates should supersede plain copper plates in gold milling. He gives numerous tables of results in support of his view, and the paper contains much useful information. In the discussion it was pointed out that in many cases the percentage of gold extracted was low in consequence of the failure of the millman to keep his plates clean, and the importance of the increased use of "elbow-grease" rather than chemicals was strongly emphasised.—Note on an improved native gold-mill, by the same author. The note gives details of an improved mill worked by overshot water-wheel erected by the Colombian Mines Corporation at Antioquia, Colombia, where the water supply was much in excess of requirements.—Note on the geology of Lake Nyasa, by Alexander Richardson. The author describes Lake Nyasa as a sheet of clear water some 360 miles in length by from 14 to 40 miles in width, lying at an altitude of 1500 feet, its deepest part being 1000 feet below sea-level. After describing the geological formations he goes on to say that whilst as yet no valuable minerals have been discovered in British Central Africa, half-caste Portuguese at one time worked alluvial gold between the Angoni country and the Zambesi, and gives it as his opinion that workable gold will be found in the mountainous region to the west. For half the year the climate is wet and malarious and for the other half dry, cool and healthy.

Royal Meteorological Society, January 16.—The President, Dr. C. Theodore Williams, in the chair.—Annual General Meeting.—Reference was made to the celebration of the Society's Jubilee on April 3–4 last, and also to the death of Mr. G. J. Symons, F.R.S., who had amongst other things bequeathed to the Society about 2200 volumes and 4000 pamphlets from his valuable library.—Dr. C. Theodore Williams delivered the presidential address, taking for his subject the climate of Norway and its factors. He considered that its meteorology should prove an attractive study for the Society as having much in common with that of our country, both the Norwegian and the British shores being influenced by the same Gulf Stream, and having their winters and summers tempered by the same equalising agency. The factors which influenced the climate were: (1) the insular character of the country; (2) the distribution of the mountain ranges, which explains to a large extent the rainfall; (3) the waters of the ocean, which, from a variety of circumstances, come into close connection with much of the country and thus temper extremes of climate; and (4) the sun, which in this latititude remains in the summer long above the horizon, and in the winter long below it. The address was illustrated by a large number of lantern slides of Norwegian scenery, embracing mountains, glaciers, fjords, &c.—The election of officers and council for the ensuing year then took place, Mr. W. H. Dines being appointed president, and Dr. C. Theodore Williams treasurer.

Linnean Society, December 20, 1900.—Prof. S. H. Vines, F.R.S., President, in the chair.—Mr. B. Daydon Jackson exhibited two editions of Hill's "Flora Britannica," the earlier, of 1759, being apparently unknown to bibliographers. This edition differs from the usual issue of 1760 in having a different title-page, and publisher's name: the copy exhibited wants the plates mentioned on the title. The species ascribed to the genus Statice are three in number; in modern nomenclature one species of Armeria and two of Statice.—Prof. Howes, F.R.S., exhibited a couple of pigeon's egg-shells, cast up at the mouth by the tropical African egg-eating snake *Dasypeltis scabra*, now living in the Zoological Society's Gardens, and called attention to the presence of a series of spiral and longitudinal fracture-lines, pointing to an elaborate co-ordinate muscular activity in the "crushing" process, the probable nature of which he discussed, in the light of the recent investigations of Katheriner into the anatomy of the animal and the observations of Miss Durham upon its feeding habits.—Prof. Poulton, F.R.S., exhibited a living specimen of the death's-head moth (*Acherotia atropos*), and proved with a stethoscope that the late Prof. Moseley was correct in stating that the sound comes from the proboscis. He also showed that all sound ceased the moment the tip of the

straightened proboscis was dipped in water, and could not be resumed until the organ was withdrawn; thus supporting Prof. Moseley's opinion that the sound was produced by forcing air through the proboscis. Prof. Poulton also exhibited projected photographs of *Acraea unicolor* var. *alcippina* recently received from Sierra Leone by Mr. Herbert Druce, together with specimens of *Limnas chrysippus* var. *alcippus*, which they closely resemble. He showed that this Acræa is represented in the South and East Central regions of Africa by varieties which correspond to the respective forms of *L. chrysippus*; that in fact the geographical coincidence between the two is much closer than with the forms of the female of *Hypolimnas misippus* and those of *L. chrysippus*. The former is one example of Müllerian mimicry, both forms being independently distasteful; while the female Hypolimnas is generally regarded as a Batesian mimic.—Mr. Arnold T. Watson read a paper on the structure and habits of the Ammocharidæ, a group of marine Polychæte worms which inhabit sandy localities and are protected by tubes of unique structure.—Mr. I. H. Burkill read a paper on the flora of Vavau, a little known island of the Tonga group, on which some remarks were made by the President.

PARIS.

Academy of Sciences, January 14.—M. Fouqué in the chair.—The President announced to the Academy the death of M. Ch. Hermite, member of the Section of Geometry, and of M. Adolph Chatin, member of the Section of Botany.—On the theory of precession, by M. H. Poincaré. The secular variations of the terrestrial equator, as determined by Stockwell, lead to an entirely different coefficient from that obtained by Backlund using the method of Gylden. It is shown on analysis that the coefficients obtained by Stockwell are correct, there being a fundamental error in the method of Gylden.—Researches in the formation of organic sulphur compounds, by M. Berthelot. A study of the thermal properties of the mercaptans, the heats of combustion and formation of ethyl mercaptan, ethyl sulphide, amyl mercaptan, amyl sulphide, and allyl sulphide being given.—New researches on the isomerism of the sulphocyanic ethers, by M. Berthelot. Measurements of the heats of combustion and formation of phenyl isosulphocyanide.—The gaseous products disengaged by the action of heat from some igneous rocks, by M. Armand Gautier. Granites from different sources were heated in a vacuum with syrupy phosphoric acid, the gas evolved measured and analysed. The quantities found were very considerable, varying from 560 c.c. to 5438 c.c. per kilogram. The gases found consisted of sulphuretted hydrogen, carbon monoxide and dioxide, methane, hydrogen, nitrogen and argon. From analyses of the gases given off at different stages, it is shown that the gases are not simply stored up in the rock, but result from reactions at the temperature of the decomposition.—On the effects of the substitution of alcohol for sugar in food upon muscular action, by M. A. Chauveau. The question as to how far alcohol can replace sugar in a mixed diet is of considerable physiological interest, the question being attacked by means of the respiratory coefficient. As a net result of a lengthy series of experiments upon a dog, it is concluded that the alcohol introduced, although very rapidly absorbed by the organism, only participates to a very small extent, if at all, in the combustions from which the muscular system draws the energy necessary to its working. The alcohol is not an energy producing food, its introduction into a food having rather the opposite effect.—On the new Giacobini comet, by M. Perrotin.—On quadruply periodic functions, by M. Georges Humbert.—On orthogonal systems admitting of a group of Combescure transformations, by M. D. Th. Egorov.—On the correlation of the experiments made at Dijon in 1894 for the application of the idea of a common return for telephonic circuits, and on experiments made since 1894 on telephony without wires, by M. Rheins.—Action of hydrogen upon bismuth sulphide, by M. H. Pelabon. The action between hydrogen sulphide and bismuth is a reversible one, and has been studied experimentally by the author at a temperature of 610° C. Three reactions were studied, hydrogen and the sulphide of bismuth, hydrogen sulphide and bismuth, and hydrogen with a mixture of sulphur and bismuth.—On the chlorobromides of thallium of the type $TlX_3 3TlX$, by M. V. Thomas.—On the combinations of the chlorides of phosphorus with boron bromide, by M. Tarible. Bromide of boron in presence of the chlorides of phosphorus react with great facility to form double compounds. These bodies, which are well crystallised, are decomposed by cold water, by chlorine, and by ammonia.—On the new mode of preparing hydrated sodium peroxide, and their properties, by M. George F. Jaubert. Although sodium peroxide when treated with water is decomposed into oxygen and caustic soda, if treated with moist air free from carbonic acid, no decomposition takes place, water being absorbed and hydrates formed. Hydrated sodium peroxide is stable in the cold, and may be kept for six months without appreciable alteration.—Determination of the latent heats of vaporisation of some substances in organic chemistry, by M. W. Louguinine. Figures are given for aniline, methylethylacetoxime, anisol and butyronitril.—Study of uranium nitrate, by M. Œchsner de Coninck. Determinations of the densities of solutions of uranium nitrate in nitric and sulphuric acids.—The oxidising action of ammonium persulphate upon some immediate principles of the organism, by M. L. Hugounenq. A study of the oxidation of uric acid, bilirubin, hematin and blood by ammonium persulphate.—On the structure of the vascular plants, by M. G. Chauveaud.—On the occurrence of a mineral smelling of free fluorine at Beaujolais, by M. Jules Garnier.—On the Neomylodon and the mysterious animal of Patagonia, by M. André Tournouër.

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THURSDAY, JANUARY 31, 1901.

THE SCIENCE OF SPECTRUM ANALYSIS.

Handbuch der Spectroscopie. By H. Kayser. Professor of Physics at the University of Bonn. Vol. i. Pp. xxiv + 782. 251 figures. (Leipzig: Hirzel, 1900.)

THERE are comparatively few men of science who can accurately handle a spectroscope and interpret its indications with assurance. The number of chemists, for instance, who could look at the spectrum of a Geissler tube, and pick out at once the lines of hydrogen, oxygen, nitrogen or carbon, is probably very small. No one denies the importance of the spectroscopic method, but its practice requires so long an apprenticeship and so severe a training, while the experimental facts are so numerous and the pit-fâlls so plentiful, that the physicists and chemists are inclined to shirk the whole subject and to leave it to the few who happen to have been brought up in a spectroscopic atmosphere.

Part of the cause of this apparent neglect is due to the want of a proper guide to lead the willing but bewildered student through the intricacies of a most diffuse and uninviting literature. We possess only a few short text-books which are quite insufficient for any serious requirements, and various catalogues of papers relating to spectrum analysis which have proved absolutely useless. Prof. H. Kayser, well known as an authority on the subject, has undertaken what must prove to be the work of a lifetime. The first volume of his "Treatise of Spectroscopy" is now completed and will be welcomed by all who desire to know, as well as by those who already know, something of this branch of science.

This volume covers 750 pages and deals, after an historical introduction, with the instrumental methods of producing and examining spectra. There can be only one opinion on the admirable manner in which Prof. Kayser has accomplished his task. He has succeeded in giving a clear and complete account of his subject, and at the same time avoided overburdening his book with details, which the reader can always find in the original papers, to which complete references are given.

The first 120 pages are devoted to the history of the subject, which is dealt with in a fair and impartial spirit. The early papers, in which ideas, *now* so obvious to us, are present in a vague and intangible form, are fully dealt with, but we naturally turn to the exciting time when Kirchhoff and Bunsen finally disposed of all vagueness and created the science of spectrum analysis. Questions of priority never remain long in an acute stage, and no one would now detract one tittle from Kirchhoff and Bunsen's merit because others may have had some correct ideas before them. Balfour Stewart came very near the truth, but it is very doubtful whether, even if his treatment of the relation between absorption and emission had been as rigid and conclusive as that of Kirchhoff, he would have carried the scientific world with him in the way the Heidelberg philosophers did. In fact, only a small fraction of the chemists and physicists who hailed the new discovery with delight could possibly have appreciated Kirchhoff's mathematical deductions. Even making full allowance for the fact that most men are more easily convinced by an argument which is entirely beyond their comprehension than by one which they partially understand, I cannot believe that the turning point in the history of spectrum analysis lay in Kirchhoff's theoretical proof of the cause of the reversal of the bright lines. The most interesting portion of the history of science lies, to my mind, not so much in studying the evolution of clear ideas from vague forebodings of truth (though that, no doubt, is of great importance), as in tracing the particular theoretical argument or experimental fact which carried conviction. In this respect, I should give the foremost place in the history of spectrum analysis to Kirchhoff's experiment, in which he actually obtained the reversal of the sodium and lithium lines, and I should give almost equal value to the clear insight and experimental skill which allowed Kirchhoff and Bunsen to assign the D lines with certainty to sodium alone. For the ubiquitousness of these lines was one of the great stumbling blocks which had prevented every real advance, by suggesting that different elements might emit the same vibrations. Even those who had recognised that the yellow lines owed their origin to the presence of a sodium salt had failed to realise that the salt itself was decomposed, and that the lines were due to the metallic element.

There is an interesting incident connected with this point which may be mentioned here, though private conversations, unconfirmed by documentary evidence, have no real value in questions of history. The late Prof. Balfour Stewart assigned his own failure to carry his researches to their logical conclusion to his ignorance of the fact that salt was decomposed in the flame. He made an experiment to see whether rock-salt exercised a selective absorption for light emitted by a sodium flame, and failing to discover such an absorption put the matter aside. But I have been carried away by old recollections, and must pass on from Prof. Kayser's first chapter, which carries the history of the subject to Zeeman's discovery, and the Baltimore experiments on the influence of pressure.

The second chapter deals with the methods of producing luminous vapours. Flames, the voltaic arc, electric sparks in various forms and conditions, and vacuum tubes are discussed in succession; and even those conversant with the subject will find a large amount of valuable information, especially as the author includes in the discussion such questions as the temperatures of different sources, and touches on the theory of the electric discharge.

The third chapter, dealing with prisms, has been written by Dr. H. Konen of Bonn. The passage of rays through prisms is traced, and full justice is done to Lord Rayleigh's investigations, though two propositions in §§ 309 and 310, assigned to Wadsworth, are really contained in Rayleigh's first paper. I think that the investigations of this chapter might have been made clearer and shorter by a more frequent application of Fermat's principle. Special attention may be drawn to the reduction of prismatic measurements to wave-lengths by means of the interpolation formulæ, which have been given by Cornu and Hartmann (§§ 327 and 328). Insufficient attention, to which I must plead guilty myself, has been given

in this country to these equations, which are much more convenient than Cauchy's formula, and which much facilitate the reduction of measurements made with prism spectroscopes. The chapter concludes with a complete description of the various devices for compound and direct vision prisms. The combination of prisms to obtain great dispersion and resolving power has lost a great portion of its interest since the more general introduction of diffraction-gratings for spectroscopic purposes. We therefore turn with special interest to the fourth chapter, which deals with diffraction-gratings.

After a short history of the methods of ruling gratings, a discussion of plane gratings is given, which chiefly follows Rowland's and Cornu's investigations. About thirty pages are devoted to concave gratings. A very clear and elegant theory of these gratings, due to Prof. Runge, is, for the first time, published in full, and deserves to be widely read. It includes the very important practical question of the easiest method of adjusting the relative position of the slit, grating and camera, so that when the carriages roll along the beams, the spectrum should remain in focus and be displaced only in a direction parallel to the plane containing the two rectangular rails.

A disadvantage of concave gratings, which has been pointed out by Rowland in his first discussion, is its astigmatism, a point on the slit being drawn out into a line. It seems to me a curious fact that no one should have attempted to correct this astigmatism by means of cylindrical lenses. I was only waiting until the large concave grating of the Owens College was available, to try some experiments in this direction. Prof. Fitzgerald tells me that he has had the same idea, and has already determined by experiment the proper position of the two focal lines of the correcting lens. In looking over the pages of Prof. Kayser's book, I find that I had overlooked a paper by Mr. J. L. Serks, in the *Journal of Astronomy and Astrophysics*, in which the question is, in fact, solved theoretically. It is curious, however, that the author does not seem to have realised this application of his investigation, which he only applied to proving the possibility of finding a position for a comparison prism such that the horizontal edges of the prism should appear sharp on the spectrum plate. If the light coming from a luminous point is passed through a combination of a cylindrical and convex lens, placed so as to give a horizontal focal line in the position given by Serks, and a vertical focal line coincident with the slit, the astigmatism of the concave grating will be corrected.

The fifth chapter discusses the construction of spectroscopes, a good deal of space being devoted to the various devices for securing minimum deviation. The author seems to me to attach a somewhat exaggerated importance to the minimum deviation as regards its necessity to give definition. If the collimator is properly adjusted, and the faces of the prisms are plane, the spectra should be equally perfect whether the prisms are in the position of minimum deviation or not. When many prisms are used it becomes, of course, necessary that each prism should wholly take in the beam of light which has passed through the previous prism, and, in that case, the position of minimum deviation is most convenient. For the usual prism, cut so that its base is equally inclined to the faces, the position of minimum deviation is also that of maximum resolving power; but the prism may be turned considerably out of the symmetrical position without sensibly affecting its power of resolution.

The theory of the spectroscope, including the question of resolving power and purity, is fully discussed; but I venture to think that the treatment of the brightness of spectroscopic images might be made much simpler and clearer, and in some cases more correct, by starting from the following two very simple principles.

It is a well-known proposition, in the formation of images by lenses, that the brightness of the image, as deduced from the laws of geometrical optics, simply depends on the emitting power of the source and on the solid angle of the converging beam forming the final image. When the observations are taken by the eye, and the whole pupil is filled with light, the last solid angle is fixed; hence the brightness cannot be altered by any optical arrangement. The same proposition also holds when the light is refracted through prisms, provided the light is homogeneous. The second proposition, to which I have alluded, states that if the object is linear, the width of the central image, due to the finiteness of the wave-length of light, also depends only on the solid angle of the conical beam forming the last image.

These two propositions enable us to draw all the necessary conclusions without restrictions, such as that made by Kayser as to the position of minimum deviation of the prisms; and the results of § 508, derived from a paper by Wadsworth, will be found to need correction in some important particulars. The latter portions of this chapter deal with Michelson's researches, the applications of fluorescence, phosphorescence, and finally with photographic and bolometric methods.

The last chapter is devoted to spectroscopic measurements.

The value of the book is increased by the fact that the author has not been satisfied with a statement of results, but in many cases has added his own criticisms. I entirely agree with the statement made in the preface, that a mere compilation without critical discussion is of very little value. In the present volume there has not been so much opportunity of touching on tender spots as will arise in subsequent divisions of the subject; but Prof. Kayser's evident fairness and knowledge of his subject render it certain that no one need be afraid of placing himself under the judgment of so competent an authority. While congratulating Prof. Kayser on the successful accomplishment of the first portion of his task, we conclude with the hope that we may soon be able to welcome a second volume. ARTHUR SCHUSTER.

LIFE AND WORK OF C. GERHARDT.

Charles Gerhardt: sa Vie, son Oeuvre, sa Correspondance: 1816–1856. *Document d'Histoire de la Chimie.* Par M. Édouard Grimaux et M. Charles Gerhardt. (Paris: Masson et Cie.)

A BIOGRAPHY which involves the history of the turning-point of a science is always interesting; and this one in particular, which tells the tale of the

struggles of a young Alsatian, who came to Paris against the desire of his father to fight his way to recognition and fame, is almost dramatic in the way in which it enlists the sympathy of the reader. The story loses nothing by being told by the distinguished son of the subject of the memoir, and by the unfortunate Edouard Grimaux, whose recent death was—at least, in part—due to the jealousy of the Government of France when any attack on its action is made by men in its official pay. Indeed, it may be surmised that M. Grimaux found in the recital of Gerhardt's combats with those in power some consolation for his own recent dismission from office.

Charles Gerhardt was born at Strassburg on August 22, 1816; he passed his schooldays at the Gymnasium there, and his father, in order to prepare young Gerhardt for the charge of a white-lead works which had fallen into his hands as the result of an unfortunate speculation, sent him to Carlsruhe, where, from 1831 to 1834, he studied chemistry and allied subjects. But, on his return to Strassburg, he found the monotonous existence of a works-manager far from his taste; and after stormy interviews with his father, at which he declared his intention to devote himself to the pursuit of pure chemistry, he entered the army as a preliminary step. This step, however, was far from leading him to the desired goal; and, deciding to abandon the calling of a soldier as rapidly as he had formed the intention of taking it up, he applied to relatives in Germany, requesting help to buy a substitute. The help was furnished by no less than Liebig, who had heard of his ability from his teacher Erdmann, and thought it worth while to secure a promising assistant by payment of 40*l.*—the necessary sum.

Needless to say, the money was afterwards refunded by his relatives.

It will be gathered from this short sketch of Gerhardt's youth that he was a young man of very decided character, and that he did not always take the surest way of gaining his desires—that, in fact, he had more of the *fortiter in re* than the *suaviter in modo*.

After having studied for two years at Giessen, then rising rapidly into repute as the first school of chemistry, Gerhardt made his way to Paris armed with a letter of introduction to Dumas and with authorisation to translate Liebig's "Organic Chemistry" into French—a task for which his bilingual education eminently suited him. At first all went well. Liebig's introduction opened to him the doors of the chemists of the day; but he failed, in spite of all efforts, to obtain a junior post. His repeated endeavours to secure a place in a laboratory where he could continue his researches were met with the advice—impossible to follow, under the circumstances—"Do some work, and you will find a place." But in order to continue his researches a laboratory was necessary; and this *impasse* barred his way for months. At last Cahours obtained leave from Chevreul for him to occupy a bench in the laboratory of the *Jardin des Plantes*. Here he carried on investigations on hellenine; and, at the same time, he published a note on the constitution of salts of organic acids and their connection with salts of ammonia.

The reader must peruse the memoir itself if he wishes to become acquainted with Gerhardt's struggles—how his too direct expression of his opinions, in words calculated to irritate rather than to gain converts to his views, hindered his progress. Indeed, his relations—afterwards so intimate and so inseparable—with Laurent, began with an encounter. But both soon found that their ideas of the necessity of a reform in chemistry, and of the manner in which it was to be carried out, were nearly identical; and they joined forces in a campaign against the ruling powers. These powers were not mollified by the manner in which the campaign was conducted. Even Liebig, his old master, might be excused for resenting words such as the following, relating to a nitrogenous substance, a derivative of cyanuric acid, to which Liebig had given the name "mellon":—"Ce n'est pas une partie seulment du memoire de M. Liebig qui est fausse, mais toute l'histoire du mellon, toutes ses transformations, toutes ses reactions." Still, that did not excuse Liebig from saying that Gerhardt reminded him of a highwayman, who attacks and robs travellers and, after having stolen their clothes and ornaments, wears them with effrontery in the streets.

These were, however, days of hard hitting; and had the contest been confined only to words, little harm would have been done. But, unfortunately, the positions of instructors in the provinces and at Paris were so badly paid (and it is scarcely improved yet) that many offices were held by one individual, and places which gave command of several laboratories were occupied by those who were disinclined to abandon any one of them. Thus the best paid of the Government offices—that of Director of the Mint—had a salary attached to it of 600*l.* a year; many of the chairs were worth little over 100*l.*; and the emoluments sometimes became the gift of an elder to a younger member of a family, and were dispensed with little regard to scientific fitness or eminence. Moreover, it is the unfortunate custom in France that if a man wants a position he must ask for it—nay, he must personally supplicate those in power to bestow it on him. Thus, a candidate for admission to the Institute must canvass the members, hat in hand, and report has it that the reception accorded to a candidate is not always flattering to his *amour propre*. But we in England have little reason to criticise; for, though admission to the Royal Society's Fellowship is, fortunately, free from such disagreeable incidents, the candidature for a chair, with its system of testimonials and interviews, might well be reformed.

To return to Gerhardt. After several years of disappointment, he was finally appointed (through Dumas' influence) to the chair of chemistry at Montpellier, at one time renowned for its medical school; here he had only 6*l.* a year to spend on apparatus, and 12*l.* to provide specimens! Moreover, he found his colleagues occupying sinecures, and anxious to retain their chairs, as such, by discouraging the attendance of students. It is exceedingly galling to a "new broom" not to be allowed to make a clean sweep; and it is difficult to keep on terms of sufferance—not to speak of friendship—with what may be disrespectfully called the old besoms. So Gerhardt's new chair was by no means a comfortable seat; and after some years he applied for, and obtained, leave of absence on half-pay—another arrangement which sounds strange in our ears. In the meantime, however, he had married Miss Jane Sanders, a Scottish lady, resident with her mother and sister at Montpellier; this union was,

from every point of view, a happy one. During his leave of absence, Gerhardt came to Paris; and again, it is strange to us on the other side of the Channel, many of whom are content with an occasional visit to the capital, to see how absence from Paris is, to a Frenchman, absence from civilisation. "La vie du province"—there is no expression which so fitly renders the *ennui* of banishment from "ce cher Paris." But to live at Paris was not necessarily to find an official position; and, after many disappointed hopes, Gerhardt finally accepted two chairs at Strassburg! "Le cumul," as pluralism is termed, has attractions, it appears, to those to whom it is offered.

Gerhardt was not long at Strassburg, however, before he succumbed to an attack of peritonitis; and, after a few days' illness, during which he regretted nothing more than the cessation of work, he passed away.

Gerhardt shared with other reformers absolute belief in his own theories, and want of patience with conservatives who would not be convinced. Patience and a more gracious manner would have not only given him a happier and more prosperous career, but would also have accelerated the acceptance of his doctrines. Still, it is difficult for us to judge. Suffice it to say that the formulæ which we still use are, for the most part, Gerhardt's. While Gerhardt referred the formulæ of compounds to the volume occupied by the molecular weight in grams contained in 22·4 litres of the gas, Laurent extended the same numerical conception to the "formulæ" of elements; while Gerhardt wrote H_2O for the formula of water, but O for that of oxygen, Laurent introduced Avogadro's and Ampère's view that the molecular formula of oxygen should be O_2. They united their forces in advocating the adoption of "types," such as that of H_2, H_2O, and NH_3; and Williamson supplemented their ideas by the addition of "double types"—substances derived, for example, from two molecules of water by replacement of an atom of hydrogen in each. Later, as every one knows, this conception developed into structural formulæ. But the idea of a homologous series, too, was first introduced by Gerhardt; and it has proved one of the most fertile in the whole domain of organic chemistry.

We have witnessed as great, if not a greater change in chemical theory during recent years. Fortunately, it has not aroused the same passion, although it has been resolutely opposed by a conservative faction. At the meeting of the French Association at Havre, the writer remembers well a discussion of which the central point was whether the formula of barium sulphate should be written $BaO.SO_3$ or $BaSO_4$. Is it possible that, twenty years hence, we shall still find a remnant for whom the ionic theory has no value?

W. R.

MONISM FOR THE MULTITUDE.

The Riddle of the Universe at the Close of the Nineteenth Century. By Ernst Haeckel, Ph.D., M.D., LL.D., Sc.D., and Professor at the University of Jena. Translated by Joseph McCabe. Issued by the Rationalist Press Association, Ltd. Pp. xvi + 398. (London: Watts and Co., 1900.)

THERE is a twofold pathos in this book, for with it the author—whom to know is to love—draws, he says, "a line under his life-work," and with it he once more illustrates the sad fact that a great investigator may not be convincing as a philosopher. The book begins with a reproach that philosophy is ignorant and that science lacks consistency, and we end it with a sigh for the same reasons. As a few readers may remember, Haeckel projected, almost a generation ago, the scheme of a "System of Monistic Philosophy"; but the shadow of age has fallen upon him while his early ambition was still not within sight of being realised. Therefore he has given us in this, "which has something of the character of a sketch-book," only a hint of what might have been. For the non-fulfilment of his dream of youth, the order of things is more responsible than the author, for there are few who have worked harder and, at the same time, more brilliantly for their day and generation.

But although Haeckel speaks of the volume as a sort of sketch-book, this is not meant to suggest that its conclusions are mere *obiter dicta*. On the contrary, as he tells us, he has been meditating for fully half a century on the problems of evolution, and now, in his sixty-sixth year, he gives us "the ripe fruit of his tree of knowledge." If this is not an altogether happy metaphor, it may serve to remind the unsympathetic that we have here, at least, the sincere voice of "a child of the nineteenth century," who is conscious of no dogmatism, though the suggestion of it seems painfully frequent, who blinks no facts so far as he is aware, who is impelled by no motive but a love of truth.

> "My 'Monistic Philosophy' is sincere from beginning to end—it is the complete expression of the conviction that has come to me, after many years of ardent research into Nature and unceasing reflection, as to the true basis of its phenomena."

Impulsive the author certainly is, as he has always been—impulsive, for instance, to champion Darwinism in the early days of its unpopularity, and impulsive in his confidence in genealogical trees which many a Jack has hewn at while the giant climbed—but ignorant no one will venture to call the zoologist who has laid so many solid blocks in the scientific edifice, and to whom the Royal Society has lately awarded its Darwin medal. There is, perhaps, no important idea in this volume, admirably translated by Mr. Joseph McCabe, which is not to be found in that wonderful work of 1866, the "Generelle Morphologie"; but the ideas are now illumined with a wealth and confidence of illustration which only a big personal share in the scientific progress of the last forty years could give.

The book, as we have said, begins with a reproach. Scientific workers "do not see the wood for the trees"; the metaphysicians "trouble not about the individual trees, and are satisfied with the mere picture of the wood"; betwixt the two is the multitude, still oppressed by "the riddle of the painful earth." But this incoherence, this ignorance, this oppression result from that blindness to the open secret of unity which is the lasting defect of Western thought. There is but one fact, and, as a writer in the *Monist* recently remarked, it is an evidence of human frailty that the word ever got a plural; there is but one science, the science of the order of nature; there is but one comprehensive riddle, the problem of substance; and there is but one hopeful attempt at solution, namely, of course, scientific monism.

We cannot here discuss the detailed arguments of the book, but the author's standing requires that we should at least indicate the general trend. The chapters run:—the nature of the problem, our bodily frame, our life, our embryonic development, the history of our species, the nature of the soul, psychic gradations, the embryology of the soul, the phylogeny of the soul, consciousness, the immortality of the soul, the law of substance, the evolution of the world, the unity of nature, God and the world, knowledge and belief, science and Christianity, our monistic religion, our monistic ethics, solution of the world-problems. It is from the last chapter that we select a quotation which sums up the author's position.

"Towering above all the achievements and discoveries of the century, we have the great, comprehensive 'law of substance,' the fundamental law of the constancy of matter and force. The fact that substance is everywhere subject to eternal movement and transformation gives it the character also of the universal law of evolution. As this supreme law has been firmly established, and all others are subordinate to it, we arrive at a conviction of the universal unity of nature and the eternal validity of its laws. From the gloomy *problem* of substance we have evolved the clear *law* of substance. The monism of the cosmos which we establish thereon proclaims the absolute dominion of 'the great eternal iron laws' throughout the universe. It thus shatters, at the same time, the three central dogmas of the dualistic philosophy—the personality of God, the immortality of the soul, and the freedom of the will" (pp. 388–389).

There seems some need here for a criticism of categories, but we make only two remarks.

Since, as Haeckel says, "no scientist ever asks seriously of the 'purpose' of any single phenomenon," since, in other words, science does not discuss the meaning or significance of experience, it is obviously *as a philosopher* that he seeks to demolish the ancient beliefs, and there will no doubt be found those who, while bowing to his scientific authority, will prefer Kant or some other as their philosophical guide.

Secondly, to scientific minds who regard laws of nature as merely conceptual formulæ summing-up certain sequences of experience, it may seem that to replace "a deliberate architect and ruler of the world" by "the eternal iron laws of nature" is to be guilty of an anthropomorphism precisely analogous to those on which the illustrious author pours contempt. Altogether, this endeavour to give monism to the multitude seems to us to bear an unfortunate resemblance to the device of trying to pay debts by means of an overdraft without first facing the question of general solvency.

When we say that we do not find in this volume any solution of any of the riddles of the universe, we mean no particular reproach against the author, for he is a scientific worker, and we do not think that it is within the scope of science to solve "Welträthsel." In other words, we adhere to the position that "all science is description, not explanation." If the phenomena which we label gravitational or evolutionary were once riddles, they remain so, although Newton and Darwin have given us what Karl Pearson calls thought-economising devices for dealing with them.

The book falls short of its high ambition because it is neither scientific enough nor philosophical enough to win conviction. It is not scientific enough, since mere formulæ (endowed with "eternal validity") stalk through the book, doing this and doing that, like the Greek gods come back again, and since when the well-known difficulties raised by the "big lifts" in the great process of Becoming have to be faced, the author has no new light to offer (we are not forgetful of his illumining work in the past), but simply rubs his lamp and summons the two genii, Substance and Evolution, and the work is done. In plain fact, Evolution travels through the book like a creator in disguise. There is many a quaint illustration of the metaphysician unconscious of himself, as when the author, after referring the doctrine of the conservation of matter and energy (his "law of substance" or "fundamental cosmic law") to Lavoisier, Helmholtz and others, says: "In the ultimate analysis it is found to be a necessary consequence of the principle of causality."

Nor does the book seem to us philosophical enough; it does not even show an appreciation of the philosopher's problems. In confessing that we are as far from understanding "the innermost character of nature," "the problem of substance" as Anaximander and Empedocles were 2400 years ago, Haeckel says:—

"We do not know the 'thing-in-itself' that lies behind these knowable phenomena. But why trouble about this enigmatic 'thing-in-itself' when we have no means of investigating it, when we do not even clearly know whether it exists or not."

Now many who agree with this assumption of the futility of the "things-in-itself" may at the same time doubt whether the philosopher troubles himself much about it either, whether this is not mere bluffing in presence of the fact that our "routine of perceptions" *is* a problem (not to be ignored, even if insoluble), whether transcendental formulæ have no utility because scientific formulæ (*e.g.* atomic theories, ether theories, &c.) seem to many minds to have much, and whether the position indicated is consistent with the energy expended throughout the book in "shattering" Christian and other philosophies of life which have obviously no standing if from the outset the problem of the significance and meaning of experience is ruled out of court as an irrelevancy. One feels that the author has not quite learned the "rules of the game" when he is satisfied with saying in answer to idealistic monism:—

"In my opinion the existence of ether is as certain as that of ponderable matter—as certain as my own existence, as I reflect and write on it. As we assure ourselves of the existence of ponderable matter by its mass and weight, by chemical and mechanical experiments, so we prove that of ether by the experiences and experiments of optics and electricity."

But this is just Dr. Johnson and Bishop Berkeley over again, and no idealist will so much as turn a hair.

SCHMEIL'S TEXT-BOOK OF ZOOLOGY.

A Text-book of Zoology; treated from a Biological Standpoint. By Dr. O. Schmeil. Translated by R. Rosenstock, and edited by J. T. Cunningham. Parts ii. and iii. Reptiles to Invertebrates. (London: A. and C. Black, 1900.)

THE first part of this school text-book was noticed in our issue of August 23, 1900, and with the publication of Part iii. the work is completed. Considering

the fulness with which it is illustrated, and the somewhat restricted circulation of treatises devoted to zoological subjects, the work is a marvel of cheapness; and the manner in which it is turned out reflects the greatest credit on the publishers. Allusion has been previously made to the popular and interesting style in which it is written; and as examples of clear and accurate treatment of somewhat difficult subjects we may call attention to the description, in Part ii., of a bird's respiration while on the wing, and the manner in which the flight-feathers present either an impervious barrier or an easily traversed sieve to the air according to the exigencies of flight at the moment. The descriptions of these functions are, indeed, decidedly better than in any other text-book with which we are acquainted; and they are by no means solitary instances, both in the vertebrate and invertebrate parts. Again, the diagram of the circulation of the carp on p. 274 may be cited as an excellent example of clearness. And it may be confidently affirmed that, so far as physiology and habits are concerned, the work is for the most part all that can be desired.

But physiology and the description of the habits of animals, although of the highest importance, by no means constitute the whole of zoology; and whether the subject be treated from a "biological" or from any other standpoint, there can at the present day be no sort of excuse for the numerous omissions and inaccuracies which occur in the systematic portion of Part ii. Even if the author's acquaintance with systematic zoology were insufficient to enable him to recognise these shortcomings, it should have been, as we said before, a part of the editor's task to see that these were remedied in the English translation.

Were we so disposed, we could seize many opportunities of finding fault with the generic and specific nomenclature employed; but we will let such minor matters pass without notice, and content ourselves with calling attention to other points.

Taking first the section on birds, we find that not only is the classification of a decidedly antiquated type, and very different from any of those commonly employed, but that it also contains several errors and inconsistencies. The group "Impennes," for example, was formed in 1811 by Illiger for the penguins, but in the present work (p. 225) we find it typified by the divers, which, together with the grebes, constitute Illiger's "Pygopodes"! Nor is this all, for whereas the "Impennes" are termed "Divers," yet no representative of the divers proper (Colymbidæ) is referred to in the work; the notice of the group commencing with the grebes, which are followed by the auks, and these, again, by the penguins—the typical and sole representatives of the entire order. Take, again, the case of the gulls or "Lariform" birds (page 223). Here we have first an account of the herring-gull, followed, under the head of "allied species," with a brief mention of the black-headed gull and the albatross. Of course, it is justifiable to follow Dumeril in including both the gulls and the albatross in a single group (Longipennes), but the reader should have been informed that, according to the universal usage of British ornithologists, the albatross and the other petrels are separated from the gulls as a distinct order (Tubinares).

To take a third instance, those responsible for the book may, if they please, follow the totally obsolete system of including the so-called American vultures (Cathartidæ) among the Vulturidæ, or true vultures of the Old World. But there is no justification whatever for taking the condor as the sole example of the latter family, and avoiding all mention of a single species that really belongs to it! And here it may be remarked that we think ornithologists would be well advised if they discarded the use of the name "Vultures" for the Cathartidæ, and called them all "Condors." Misprints, we are glad to notice, seem few and far between in this and the other sections of the book, but Alaudictæ, in place of Alaudidæ (p. 181), should have caught the proof-reader's eye.

Passing on to the section on reptiles, we have to deplore the use of an antiquated and discredited classification, the groups Ophidia and Lacertilia being regarded as of equal value with Crocodilia and Chelonia. But even more serious is the total absence of the Rhynchocephalia among the ordinal groups of the Reptilia, its single representative, the New Zealand tuatera, being, so far as we can see, not even mentioned in the book! Surely, even from a "biological standpoint," such a remarkable creature is worthy of some notice in a "zoological text-book!"

Nor are minor points for criticism lacking in this section. For instance, on p. 246, the account of the American alligator is simply ludicrous; while the reader should have been informed that an allied species occurs in China. Again, had the editor taken the trouble to refer to the British Museum "Catalogue of Chelonians," he would have found that there is no justification for the use of the name "Chersidæ" for the land tortoises (p. 250), and also that in place of *Testudo indica* being the proper title for the "giant tortoises" of the Galapagos Islands, that name denotes an extinct species from the Mauritius.[1]

Omitting mention of the Amphibians (not because there is no room for criticism), a few remarks are called for in the section devoted to fishes. Here the up-to-date zoologist can scarcely fail to be surprised to find the group divided into (1) bony fishes, (2) enamel-scaled fishes, (3) sharks and rays, (4) round-mouthed fishes, and (5) lancelets, without the slightest indication as to differences in the value of such divisions. To those who have kept themselves at all abreast of modern zoological research, it is almost inconceivable that such a classification should be presented to students.

As regards the details of the class in question, it is decidedly strange to find the "enamel-scaled" group exemplified by the sturgeons, while the two living types (bony pike and bichir) which alone retain scales of this description are totally ignored; and surely the unique type of limb-structure presented by the latter alone among modern fishes should have itself entitled the creature to special mention. Even more startling is the omission of any reference to the lung-fishes (Dipnoi), which we presume the author would include in the "enamel-scaled" group, although the student is left entirely in the dark on this important point.

Without in any way wishing to be unduly severe, we

[1] Neither the popular nor scientific name of this reptile occurs in the index.

can scarcely refrain from saying that in the second part of the work the author seems to have gone out of his way to ignore some of the most peculiar, and therefore the most instructive, types of reptile and fish life.

As regards Part iii., which deals with invertebrates, we feel ourselves less qualified to speak authoritatively either in respect to the excellence of treatment or the reverse on the part of the author, and therefore refrain from detailed criticism. So far, however, as we can judge, the classification adopted is, in some respects, less open to objection than is that of the vertebrates. Even here, however, the author gives opportunity for criticism in many places. For example, among the molluscs no mention is made of Dentalium, which most modern zoologists regard as the representative of an order by itself. And it is scarcely consonant with the facts to say (p. 445) that Ammonites "were animals similar to the nautilus in all essentials of form and structure," unless, indeed, the author attaches a very different meaning to the word "essential" than we are disposed to assign to it. But the most astounding feature in the whole book is the total omission of the Brachiopods, the Tunicates, and the Polyzoans!

At the end of the work two pages are devoted to geographical distribution. Here it will surprise many zoologists to find the domesticated zebu given as one of the characteristic animals of the Indian region, and "the antelope" as one of those of Africa. Neither is it apparent why the leopard *and the panther* are included among the characteristic mammals of Africa as distinct from India. Again, the statement (p. 485) that "tracts of land (*e.g.* the Sahara) have been elevated out of the ocean" may be cited as an extremely unfortunate one, having regard to modern views as to the origin of deserts.

If the editor in his preface is justified in his statement that "the book is far superior in many respects to any other elementary text-book of the subject known to me," we may be permitted to add that in other respects it is decidedly inferior to several works of the like nature that could be named. R. L.

OUR BOOK SHELF.

The Mycetozoa and some Questions which they Suggest. By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., F.L.S., and Agnes Fry. Pp. viii + 82. (London: *Knowledge* Office, 1899.)

"WHAT'S in a name?" Much, when it bars the way to the knowledge of a group so rich in curious and beautiful forms, and so important in the information that it can afford upon the nature of protoplasm. The want of a familiar name has led the authors to employ "myxies," and the word may find acceptance, as it is not hard to pronounce or remember, while it has the advantage of leaving open the question of what their pets are. Though generally reckoned now among plants, they are so different from even the nearest groups that they may well receive a neutral name.

They have formed the subject of very excellent monographs in various languages, and to these the student must turn who wishes to investigate the Mycetozoa thoroughly. But the very excellence of these monographs renders them unsuitable to those that wish only such a general outline as will place the group in true perspective in its relation to other low forms of living beings, and will indicate its value in the study of living protoplasm in simple organisms. There was room for a small book that would give such an outline, and this little work has been written to do so. One cannot read it without recognising that it is the work of enthusiasts whose aim is to communicate to others the pleasure gained by themselves in the study. But no less evident is the clearness of statement of the points of chief interest resulting from width of view and facility of expression. One can recognise that it is the work of amateurs by occasional slips, as on p. 35, where it is stated that all plants with a square stem and lipped flowers belong to the family of the Labiatæ. But such slips are few, and no one can read the book without interest, while those not already familiar with the Mycetozoa will have gained as clear a conception of their nature and scientific interest as can be acquired without actual personal study of these organisms. The descriptions are supplemented by figures admirably selected and executed. The book is one that should induce those who read it to desire a fuller knowledge and to become students themselves. It will be found an excellent introduction to the study of a most interesting group.

A School Chemistry. By Dr. John Waddell. Pp. xiii + 278. (New York: The Macmillan Co., 1900.)

MANY text-books of physics and chemistry are now constructed upon the interrogatory plan. Judiciously used, the method has real educational advantages, for it makes the student think for himself instead of merely using his brain as an absorbing medium for what he reads or is told. But the Socratic principle is often overdone. The questions which a teacher asks—either in book or verbally—in connection with experiments in progress, are frequently not those which present themselves to the mind of the student. True, by suggesting questions the pupil can be led to see the main points to be brought out, and to have an interest in finding answers to them; but the ideal plan is to let his own mind do the questioning instead of the mind of the teacher. While, therefore, we agree that the interrogative method largely employed by Dr. Waddell is often stimulating, and certainly much better than the plan of former text-books for schools, we do not believe it is altogether satisfactory.

Consider a boy in a laboratory, with Dr. Waddell's book open at Experiments 9 and 10 (Chap. ii.). The experiments are on the decomposition of water by potassium and sodium, and will often result in accidents unless performed under the eye of the teacher. But leaving this out of account, let us see the questions asked in the course of the description of Experiment 10; they are as follows: "Does the potassium sink in the water, or does it float? What colour has the flame? . . . What shape does the sodium assume? Note how far it acts like potassium, and how far it differs. Is there a flame? Try the experiment with *hot* water. . . . Why is there a flame in some cases with the sodium and not with others? What is the colour of the flame? Does sodium or potassium act the more violently on water?" Now a question we would ask is: How is the pupil to give his answers? Is he supposed to write a reply to each interrogation, or merely to make a mental note of it? If the former, then the pupil must soon get weary of the obstacles offered to the progress of his practical work by the everlasting questions prompted, not by his own curiosity, but by a book. In fact, we do not believe it is possible to carry out the Socratic method of science instruction successfully by means of a text-book. The spirit of inquiry must come from within, or be inspired by a teacher watching the progress of an experiment.

It must not, however, be concluded from the foregoing that Dr. Waddell's book is destitute of the elements of

success. He does not use the plan of questioning to the excess characteristic of some other authors of recent text-books of chemistry; and his book has some special features which make it worth adoption in elementary classes in schools and colleges. The intelligent order in which the subjects are dealt with, and the attention given to industrial processes, are particularly worthy of credit.

Die Photographie im Dienste der Himmelskunde. Von Dr. Karl Kostersitz. Pp. 53. (Wien: Carl Gerold's Sohn, 1900.)

THIS short monograph is a reprint of a lecture given by Dr. Kostersitz before the Vienna Photographic Society. The author describes in a somewhat general way the results that have been obtained by applying the camera to the end of a telescope and turning it towards the heavens. We are thus introduced to the appearance of the general features of the sun in and out of an eclipse, and a brief reference to the planets and asteroids as shown us by photography. Meteor photography is more fully described, and the author here gives two illustrations showing trails as photographed by him. The method of determining the relative brightness of stars by photographing them slightly out of focus is described, and a few words are written about the photography of the Milky Way. The illustrations, which are numerous and good, are chiefly from Scheiner's "Photographie der Gestirne," there being two excellent heliogravures showing the nebula of Orion and Barnard's Milky Way.

The last portion of the book is devoted to the publication of twelve replies that were received from different authorities in answer to a suggestion, proposed by the author, of erecting an observatory on the top of the "Schneeberg." These form interesting reading, although they hardly have any connection with the subject-matter of the book itself.

Although the monograph does not pretend to be complete, yet it gives the reader an idea of the important part played by photography in astronomy.

Die Säkular-Verlegung der Magnetischen Axe der Erde. Von W. van Bemmelen. (Observations made at the Royal Magnetical and Meteorological Observatory at Batavia.) Vol. xxii. Appendix i. Pp. 30.

THIS is an attempt to trace the position of the earth's magnetic axis during the last three centuries, on the supposition that a knowledge of magnetic declination is sufficient to determine the direction of its axis. Great circles drawn through different points, and coincident at these points with the magnetic meridians, would intersect in the poles of the magnetic axis, if the earth were a uniformly magnetised sphere. As this is not the case, the circles all pass through an arctic and an antarctic region instead of through two points, and Mr. van Bemmelen calculates by the method of least squares the point in each region which is nearest to the circles. The two points thus found he takes for the intersections of the magnetic axis with the earth's surface. The reader must be referred to the original for the clever manner in which the calculations are simplified and carried out. The method is first tested for the year 1885, when it is found that the magnetic axis, calculated in this fashion, agrees closely with that derived from the more rigorous analysis of Neumayer and Ad. Schmidt. It is then applied to the declination values for the years 1600, 1650, 1750, 1770 and 1842, and the author draws from the results thus obtained the conclusion that the magnetic axis does not revolve round the geographical axis, but that there seems to be a tendency to revolve round Nordenskjöld's aurora pole. A doubt must necessarily arise in the mind of the reader as to how far the older observations are sufficiently numerous and correct to allow any certain conclusions to be drawn from them. Any one looking at Neumayer's Atlas (Berghaus) of Terrestrial Magnetism will be struck at once by the fact that the distribution of magnetic declination in the year 1600 is represented as being widely different from that of a uniformly magnetised sphere. We must conclude that either the observations were not sufficiently accurate to give us a correct picture, or that the earth differed much more from a uniformly magnetised sphere at that time than it does now. As v. Bemmelen has only tested his method at a time when the deviations from uniformity were small, there is considerable doubt whether equally good results would be obtained with irregular magnetisation. The work, meritorious and interesting as it is, cannot, therefore, be said to have led to any conclusion which can be accepted without further evidence.

The Theory of Commutation. By C. C. Hawkins. Pp. 81. (London: J. Tucker, no date.) Price 2*s.* 6*d.*

IN this pamphlet Mr. Hawkins enters into a complete mathematical investigation of the reactions occurring during the process of commutation in continuous current dynamos. The author first examines the case in which the contact resistance of the brushes is neglected, and then proceeds to give a complete solution of the equation for the current in the short-circuited coil, taking into account this resistance. This solution is due to Prof. Arnold and Dr. G. Mie, but our thanks are due to Mr. Hawkins for introducing it into England and for pointing out its practical bearings. Mr. Hawkins shows that the contact resistance is of the greatest importance in preventing sparking; the employment of carbon as the material of the brushes is consequently desirable, since the contact resistance of carbon is about fifteen times that of copper. Allowing for the fact that the surface needed to collect the same current must be about five times as great with carbon as with copper, the carbon brushes are still, approximately, three times as good as copper. The author also points out the other considerations affecting sparking, and goes fully into the question how it may be best avoided, both in dynamos and motors. The mathematical investigation is made clearer by the application of the results to a practical case, and by a careful explanation of the physical interpretation of the equations.

Album of Papúa. Types II. North New Guinea, Bismarck Archipelago, German Salomon Islands. By Dr. A. B. Meyer and R. Parkinson. About 550 figures on 53 plates in heliotype. (Dresden: Stengel and Co., 1900.) Price 50*s.*

THROUGH the energy and skill of Mr. Parkinson, Dr. Meyer has been enabled to publish a second album of photographs illustrating Melanesian ethnology. The present album supplements the first one, which was published in 1894, and is now out of print. The photographs are well taken, and give us instructive glimpses of native life. The short explanation of each plate is printed in German and English, and these little accounts frequently contain notes of great interest, and there are helpful references to previous publications. There is a photograph (pl. xxiii. 2) of a girl playing the "pangolo." In his admirable memoir on "The Natural History of the Musical Bow," Mr. H. Balfour gives an account of the playing of this interesting musical instrument, which differs from that described by Meyer and Parkinson, the original account of the pangolo, by Dr. O. Finsch, being insufficient. Mr. Balfour evidently read into Finsch's figure more than it was intended to convey.

Albums such as these are of very great service to students at home, as good illustrations are much more readily grasped than are long verbal descriptions, and we hope that other albums will follow in due course. This is not the first time that Mr. Parkinson's labours in ethnology have been recognised in NATURE, and we only wish that some of our British residents and traders

in Oceania and elsewhere would follow the good example of this indefatigable and public-spirited German trader.

The Story of Thought and Feeling. By F. Ryland. Pp. 219. (London: George Newnes, Ltd., 1900.) Price 1*s*.

PSYCHOLOGY is not for those who require spoon-feeding. Many, however, nowadays need a rallying-point for allusions in current literature to a fashionable science, and some would fain still perturbations aroused by the self-consciousness of their children's teachers. To such Mr. Ryland offers a little book which is clear and concrete, and as condensed as possible without loss of these qualities. He confines himself to an interesting account of certain mental phenomena, aims rather at description than explanation which can be controverted, and his book is excellent of its kind. Mr. Ryland is familiar with the most modern authorities, and presents a fascinating subject-matter attractively. Mental imagery is most successfully treated. Mr. Ryland employs the selectiveness of attention inadmissibly as an argument against any form of materialistic theory (p. 22), and he is too vague on the relation of will, self, and kindred formulæ; but his story is so far a story that it in general steers clear of controversies the solution of which lies beyond its scope. It can be confidently recommended to the public for which it caters. H. W. B.

A Primer of Astronomy. By Sir Robert Ball, LL.D., F.R.S. Pp. viii + 183. (Cambridge University Press, 1900.) Price 1*s*. 6*d*. net.

WHILE in many respects this little book seems likely to provide a useful introduction to the study of astronomy, it is to be regretted that greater assistance is not given to those desirous of observing the heavens for themselves. Even without the aid of a telescope the beginner may easily make observations, more particularly of apparent motions, which will go far to encourage a real interest in the subject.

A wide range of subjects is touched upon, and most of the explanations are clear and concise. Many of the descriptive parts are also excellent. Some of the more elementary phenomena, however, as the phases of the moon, receive very scant treatment, and the principal astronomical instruments are neither illustrated nor adequately described. Eleven beautiful plates, mostly from well-known photographs, form the most notable feature of the book.

Hand in Hand with Dame Nature. By W. V. Burgess. Pp. x + 240. (Manchester: Sherratt and Hughes, 1900.)

RURAL life and scenes contemplated in an expansive frame of mind provide excuses for the publication of many pretty books. This one does not differ essentially from many others fashioned on the same model. A country scene, a general knowledge of natural history, an impressionable nature, and a certain facility in the expression of poetic sentiment, seem the chief qualifications of the contributors to literature of this kind. A preface is followed by a "prelude," a dog is "a canine friend," and its runs are "peregrinations." We also read of "larks singing in the meridian blue," the brook "which whilom rippled its pure waters over a bed of cleanest sand," "the realm of spiritual immutabilities," "the obyte of summer," and other fanciful matters. The book is not without some attractive and instructive notes on animate nature, but they are almost lost in a maze of platitudes and inconsequent remarks. The statement on p. 39 that grains of corn "have been found in Egyptian mummy-cases, from which marvellously prolific stems have been raised in this country" contains a popular belief as to the growth of mummy-wheat which has been shown over and over again to have no scientific foundation.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Eclipse Photography.

IN a previous letter (vol. lxii. p. 246) the writer called attention to the possible advantage of positive or reversed photography and development in the light in its application to eclipse work. Since that time very considerable improvement has been made in the methods, and it is now easy to develop, in direct sunlight, plates which have been somewhat over exposed. The pictures obtained in this way are as clear and sharp as any that can be obtained in the dark room by ordinary methods. But I have not been able to secure details on such plates that cannot be secured on a negative by ordinary means. In addition, the over-exposure needed in order to obtain a fine picture is not yet small enough to warrant the usefulness of reverse photography in eclipses.

In the measurement of the actinic values which are required to yield various results on the photographic plate, a discovery has been made which will be of value in the development of eclipse photographs. It has been found that a plate which has been over-exposed as much as two thousand times can be developed as a clear, sharp negative in the dark room. This can be done by the addition of four or five drops of saturated hypo solution to a two-ounce bath of hydrochinone developer. A half ounce of Cramer's mixed hydrochinone bath with an ounce and a half of water and five drops of the hypo solution in place of the potassium bromide, gives clear and brilliant negatives, but they are slow in developing. They can probably be developed more quickly by making the bath more strongly alkaline. With a normal exposure, the addition of two drops of hypo enormously retards the development. The plate may look perfectly clean for half an hour or more, but the picture will surely appear by giving it time and keeping the bath in absolute darkness. It may require an hour and a half or more to secure complete development. With experience, which may easily be obtained in the use of the hypo-developer, there is no need that any valuable photographic plate should ever be lost by over-exposure if a proper exposure has been attempted. If the plate cannot be replaced, and loss from over-exposure is possible, a trace of hypo should always be used at the start in the developer.

With the hypo developer it is possible to develop on a Cramer "Crown" plate, either in the dark room or in the light room, any exposure not in excess of one million candle-meter-seconds. The highest limit of exposure for the development of good negatives in the dark room is one which permits the development of positives in the light. A plate two thousand times over-exposed may be developed either as a positive or as a negative. FRANCIS E. NIPHER.

St. Louis, Mo., January 12.

P.S.—This communication has been made somewhat prematurely, in order to direct the attention of those who will take part in the work of the next eclipse to a matter which may have great importance. It may be that the over-exposures with which I have been dealing are less than has been stated. It is, perhaps, open to question whether a fast plate under a thin positive, and exposed in a printing frame for three-and-a-half minutes at one meter from a three-hundred-candle incandescent lamp, is two thousand times over-exposed. There is, however, no difficulty in developing such a plate as a negative.

The Jamaican Species of Peripatus.

Peripatus jamaicensis, Grabh. and Ckll., was described in NATURE, vol. xlvi. p. 514. At that time it was supposed that all the Jamaican specimens represented a single variable species, but the differences observed were considerable, so that the writer (*Zool. Anz.*, xvi. 341) later separated two "mutations," named *gossei* and *swainsonae*. M. E. L. Bouvier has of late years been making admirable studies of Peripatus and its allies, and having procured from London and Cambridge the original Jamaican specimens, he finds that there are in reality two species represented (*Q. Journ. Micr. Science*, xliii. 755). These he classifies as follows:—

(1) *Peripatus jamaicensis*, Gr. and Ckll.
 (*a*) mut. *swainsonae*, Ckll.
 (*b*) mut. *gossei*, Ckll.
(2) *Peripatus juliformis*, Guild., var. n. *gossei*, Bouvier.

Unfortunately, however, the type-specimen of mut. *swainsonae* had twenty-nine pairs of legs, and was *P. juliformis gossei*. This specimen M. Bouvier so identifies, but he overlooks the fact that it is the type of *swainsonae*, and must therefore bear that name. The dark variety of *P. jamaicensis*, which M. Bouvier calls mut. *swainsonae*, may be termed mut. *bouvieri*, and the proper classification will be as follows:—

(1) *Peripatus jamaicensis*, Gr. and Ckll.
 (*a*) mut. *gossei*, Ckll.
 (*b*) mut. *bouvieri*, Ckll. (*swainsonae*, Bouv.).
(2) *Peripatus juliformis*, Guild., var. *swainsonae*, Ckll. (*gossei*, Bouv.)

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., January 4.

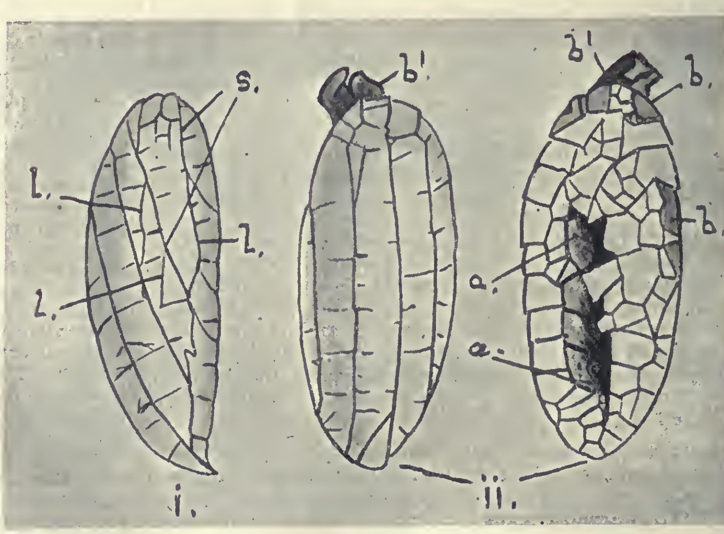
DASYPELTIS AND THE EGESTED EGG-SHELL.

A CHARMING FACT IN NATURAL HISTORY.

ANXIOUS that my pupils should see things about which they hear in the course of their class-work, I have recently lodged with the Zoological Society a standing order for an assortment of "quids," which, mostly of the nature of non-assimilable food, with occasionally a gizzard lining, are thrown out at the mouth by certain birds, snakes, and other creatures, in conformance with a habit extending to the anthropoid apes, since even the famous Chimpanzee "Sally" had acquired it (*P.Z.S.*, 1885, p. 674)—a habit most marked in certain whales, which will thus egest the whole skin of an animal devoured and flayed before being digested.

Among the first set of "castings" which I received were the two pigeons' egg-shells herein delineated, which were "thrown" by the egg-eating snake *Dasypeltis scabra* during the spring of 1900. This animal, confined to tropical Africa, shares with the Indian *Elachistodon* the unique feature of possessing vertebral "teeth," recently proved by Kathariner (*Zool. Jahrb.* Bd. xi. Anat. p. 501) to be, in the African species, true hypapophyses, toothlike but destitute of enamel, which mostly project towards or into the œsophageal lumen, through its median dorsal wall. The two snakes are members of distinct sub-families, and, in their isolation and independent occurrence, they furnish an ideal example of the principle of "convergence," by the process termed by St. Hiliare for Dasypeltis itself the "balancement" and now better known as the "substitution" of organs, as is proved for this snake by Kathariner's assertion that the reduction of its true teeth is effected during ontogeny. *Elachistodon* is unfortunately known only from two examples, and although it occurs in the Bengal area, it is unrepresented in our national collections.

Kathariner, in Dasypeltis, describes hypapophyses for each of the first thirty-four vertebræ, and of these the first twenty-six are much swollen basally, their minute pointed extremities lying each within a surrounding œsophageal lip, in such a manner as to suggest that they come into action only under pressure. The remaining eight are elongated, and with the exception of the last are converted into cutting organs, which perforate the œsophageal roof when at rest. The feeding habits of this animal have been described by Miss Durham in the *P.Z.S.*, 1896, p. 715, and she states that egestion of the shell occurs on the average one and three-quarter hours after the first seizure of the egg. No observations have hitherto been published on the egg-shell as disgorged, and unexpected interest attaches to this, from the fact that the two shells herein described differ to a marked extent in the evidence they furnish of the nature of the processes at work. Both agree only in the presence of a deep indentation (Fig. ii. *a*—*a*). As examined in the dried shell this gives the impression of a definite rent, through which the egg-contents would appear to have been discharged; but as its precise nature cannot be decided without maceration, which would lead to a sacrifice of one of the shells, I leave the settlement of this to the future. Whether it be a cut or a mere depression, it is beyond doubt due to the action of the perforating hypapophyses; for while it is limited to what would appear to be the area of apposition between these and the convex shell surface when in contact, its edges may be inrolled as under pressure from without; and the main reason I have for doubt is that in the larger egg (Fig. ii.) the shell-membrane (*b′*), ragged and torn, projects freely from the upper end, as though the discharge of its contents had been there effected. The shell-area surrounding the afore-named indentation (Fig. ii.) is in each case flattened and somewhat irregularly broken up, the whole presenting



Rough outline drawings of pigeon's egg-shells orally egested by the egg-eating snake, *Dasypeltis scabra*, to show fracture lines and limits of the incision for apparent discharge of the contents. *a*, incision; *b*, areas from which shell-fragments have been removed; *b′*, ruptured shell-membrane; *l*, longitudinal fracture lines; *s*, spiral fracture lines; *i*, non-flattened surface × 1½; *ii*, flattened and non-flattened surfaces of a second shell × 1½.

an appearance unquestionably due to pressure, but whether by contact with the anterior or posterior set of hypapophyses, it cannot at present be proved.

It is concerning the non-flattened shell-area that the conditions are most novel and interesting, for this, though brittle and subjected to a crushing action, is not, as would be imagined, irregularly broken up. The lines of fracture, in places irregular, are for the most part uniformly recurrent and equidistant. In the shell first examined they were found (*s*, Fig. i.) to be mostly longitudinally spiral and broken up in the intervening areas by cross-lines either transversely spiral or feebly transverse; and in consideration of the fact that the pigeon's egg is spirally rotated during its descent of the oviduct and as its shell is superadded, the conclusion suggests itself that the lines of fracture might be those

of a structural differentiation of the shell-substance, rendered pliable by a possible digestive action of the snake's œsophagus or buccal glands. This idea, however, is at variance with the fact that for the second shell (Fig. ii.) the chief lines are longitudinal, and the lesser, so far as they can be recognised, transverse. Of the whole series of lines, the longitudinal and longitudinally spiral are much the more marked, the lesser of the transverse series being much feebler and often incomplete—so much so that they mostly present the appearance of mere superficial scratches, visible only in certain lights, which, by thinning the shell, facilitate its distortion without breakage under pressure. Over the flattened area, however, they become actual "cracks," breaking clean through.

The question thus arises whether the main lines of fracture, if predetermined by shell-structure, may not involve the bird's oviducal wall, or whether the whole result may not be the work of the hypapophyses, under a co-ordinated muscular action of the snake's œsophagus, and it becomes necessary to inquire whether the rotation within both this and the pigeon's oviduct may not be a variable process, especially when it is found that in the shell of Fig. i., which is spirally fractured, there are three longitudinal lines recognisable (*l.*) though of variable extent.

The most conspicuous feature of the main fracture-lines is their regular recurrence and intersection at right angles—*i.e.* they are essentially cancellous. The regular recurrence of the hypapophyses suggest an obvious association with them, but this can only be determined on the death of the snake. If, as seems most likely, the distances between these and the fracture-lines will be found identical, there will remain no question as to how the latter arise. Spiral rotation of the egg beneath the anterior hypapophyses might well produce, under pressure, the spiral and transverse lines of both Figs. i. and ii. Kathariner's description of the condition of the parts, which gives us for each an elastic pad with a central stiletto, are just such as would be required to produce the result observed; and if this be due to the action of the anterior hypapophyses alone, the presence of the lines over the flattened area will be explained, by their being formed before the cutting "teeth" are brought into action.

The regularity of the fractures would seem to favour this view, and if it be correct, one can only marvel at the exquisite delicacy of the muscular apparatus concerned and its co-ordinate activity; but there still remains a difficulty in the case of the longitudinal lines, as it is hardly conceivable that the snake's œsophagus, distensible though it is, could accommodate so large an egg transversely placed.

The slight extent to which, where most fully fragmented, pieces of the shell may break away (as at *b*, Fig. ii.), is a striking feature, and it becomes the more interesting by Kathariner's discovery that the head of the intestine is so modified that it would oppose their passage should they reach it. Both the main longitudinal and spiral lines, as has been said, can be traced into the flattened shell-area, despite the fragmentation of that, and this would seem to justify the belief that the expulsion of the shell-contents must be a slow process, an inverted peristalsis, taking place during the egestive act.

The whole matter bristles with interest and suggestiveness. Thanks to Dr. P. L. Sclater, I am assured the shells which may yet be cast up by the snake now living in the Zoological Gardens, and the carcass of the animal when dead, for the further study of detail. I cannot, however, refrain from bringing to the notice of the scientific public a topic so fascinating as that herein dealt with, since it is one of those exquisite things which only organic nature reveals, and that but rarely.

G. B. HOWES.

THE LIVERPOOL MUSEUM AND PROGRESS.

OUR attention has been directed to a correspondence now taking place in the Liverpool press, *à propos* of a recent meeting of the Biological Society, at which questions were raised as to the disposal of space in the newly-erected extension of the city Museum and the rearrangement of the collections which must thereby ensue. The subject was introduced by Mr. Isaac Thompson, a past president, and continued at length by Prof. Herdman, in his capacity as the founder and leader of the Liverpool Biological School; and the undisguised theme was a protest against the non-communicativeness of the Museum Director and his committee of management, as to their intentions for the future development of their work. These gentlemen, it appears, who, with the sole exception of the Director himself, are in no way scientific, do not choose to consult Prof. Herdman and his co-workers, by whose long years of devoted labour the Liverpool School of Biologists have come to occupy a foremost position among the schools of the United Kingdom, more especially in matters pertaining to the fisheries and of economic importance. The claim which the local scientific men now raise is that their body shall be adequately represented on the Museum Board, and that immediate provision shall be made by this Board for the establishment of collections bearing on the nature and progress of oceanographic research and the fisheries, as more particularly representing the Liverpool area, regarded as a centre of local activity. And they also desire the display of objects of local interest, which shall in some measure reflect the latest advances in our knowledge of nature's operations.

The movement has been immediately taken up by the Liverpool geologists, who have also held a meeting of protest; and the general concern on the part of the combined Liverpool natural history societies is, as to whether the *régime* of the past, under which the Museum, controlled by persons mostly destitute of knowledge and experience of scientific affairs, shall remain a general emporium, having for its object the vain endeavour to fulfil the functions of a great central national museum, or whether it shall be made the centre of accumulation and display of all natural objects of local interest, supplemented only by such others as shall mark, in more especially its philosophic and educational aspects, the groundwork and recent progress in the natural history sciences. General collections from afar and costly *rarissimae* will be forthcoming so long as the exploring Liverpudlian and the enthusiastic amateur exist, while the Directorate cannot be denied the power of purchasing such things, within reason, when so minded. It is with the work-a-day aspect of the Museum, as a rate-supported institution, that advancement is now desired, and most assuredly the latter of the afore-mentioned courses is, for this, the right one, as it is that dictated by general progress in all that pertains to museum work throughout the country, and by common sense. And if this be so, the members of the Liverpool Biological Society, the older and more experienced of whom, under Prof. Herdman's guidance, have become universally recognised experts, having by their labours earned, as loyal citizens, a right of control, constitute a very suitable and competent body of men available for consultation, in itself the first necessary step for the proper strengthening of the Director's hands, if he is to be free and efficient as chief administrator.

Z. T. GRAMME.

M. ZÉNOBE THÉOPHILE GRAMME, who died last week at the age of seventy-four, was one of the pioneers of electrical engineering. He was born in Belgium in 1826, and was brought up as a carpenter; a taste for mechanics led him to attend some scientific

lectures at Liège, and subsequently he came to Paris and entered the "Alliance" factory as a workman. At this factory were built dynamos and arc lamps for lighthouse purposes, and here, as well as at the workshops of Ruhmkorff, where he also worked, Gramme managed to obtain a mastery of the principles of electric currents. The development of the dynamo, although it proceeded rapidly after the discovery of magneto-electric induction by Faraday, had not at that time attained a sufficiently high degree of perfection to give the machine then made any great industrial importance. In 1870, a few years after the discovery of self-excitation by Wilde, Gramme invented the ring armature which has since borne his name. This type of armature had been practically invented before by Pacinotti, a student at Pisa University; but Pacinotti's invention was before its time, and failed in consequence to obtain the recognition it deserved. It was reserved for Gramme, in re-inventing the ring armature, to produce a dynamo which rapidly obtained great commercial importance.

An interesting fact in connection with Gramme's armature is that the English patent was quite inadequate for so important an invention. The reason of this was that at the time the final specification was drawn up Paris was besieged, and Gramme's English agents were unable to obtain all the information they required. Gramme's machine was self-exciting, and combined good commutation with good lamination of the armature core. Also it is noteworthy that, at a time when the principles of the magnetic circuit were not understood, and when it was consequently impossible to design a dynamo mathematically, Gramme's machine had a fairly well proportioned magnetic circuit. Gramme had, without doubt, the engineering mind which is able to feel instinctively whether a machine is well designed or not. Gramme's machines were conspicuous at the Exhibition at Vienna in 1873, at Philadelphia in 1876, and at Paris in 1878 and 1881, and probably owe their success as much to the energy with which they were introduced to the world as to their great intrinsic merits.

Gramme was an Officer of the Legion of Honour and a Chevalier of the Order of the Iron Crown of Austria. In 1897 he was made a Knight Commander of the Order of Leopold, and a banquet was given in his honour at Brussels to celebrate the occasion. He died at his home, near Paris, on January 20, and was buried in the cemetery of Père Lachaise on January 23.

NOTES.

IN consequence of the lamented death of Her Majesty the Queen, and as a sign of mourning, all the meetings of scientific societies announced for the latter half of last week and the whole of this week have been postponed.

THE Amsterdam Genootschap ter Bevordering van Natuur-, Genees- en Heelkunde has awarded the Swammerdam gold medal for 1900 to Prof. Dr. C. Gegenbaur, of Heidelberg. This medal was instituted by the Genootschap in 1880, to be awarded every ten years to the person who in those years made important researches in the sciences cultivated by Swammerdam. It was awarded for the first time, in 1880, to Prof. Dr. C. Th. von Siebold; and the second time, in 1890, to Prof. Dr. Ernst Haeckel.

WE have with deep regret to record the death of Dr. Walter Myers, which took place on January 20 at Pará from yellow fever. It will be remembered that Drs. Durham and Myers went out last June for the Liverpool School of Tropical Medicine to study yellow fever. Both these gentlemen fell victims to their devotion to science, and the latter unfortunately lost his life. The world can ill afford to lose a man of Dr. Myers' stamp, for not only did he show great promise as a scientific worker, but he had the courage and singleness of purpose to go out in the cause of science and humanity to study a very infectious and fatal disease. Many have courage to face bullets in a moment of excitement, but not all have the nobler courage to face an insidious disease with the coolness and nerve necessary for scientific inquiry.

Science announces that Dr. H. C. Bumpus, professor of comparative anatomy at Brown University, and director of the biological laboratory of the U.S. Fish Commission at Woods Holl, has been appointed curator of invertebrate zoology and assistant to the president in the American Museum of Natural History, New York City. The office of assistant to the president, Mr. Morris K. Jesup, is an important executive position, as the Museum has no scientific director. It was created last year and was filled by Prof. H. F. Osborn, who has resigned in order to devote himself more exclusively to research in vertebrate palæontology. A further reorganisation of the staff of the Museum has been made. A department of mineralogy has been formed, with Dr. L. P. Gratacap as curator, while Mr. R. P. Whitfield remains curator of geology, with Dr. E. O. Hovey as associate curator. Prof. Franz Boas and Dr. Marshall H. Saville have been made curators, the former of ethnology and the latter of Mexican and Central American archæology, though Prof. F. W. Putnam retains the head curatorship in the department of anthropology. In the department of mammalogy and ornithology, Mr. Frank M. Chapman has been made associate curator.

A DISCUSSION on the occurrence and detection of arsenic in manufactured products has been arranged for the next meeting of the Society of Chemical Industry, to be held on February 18.

THE Anatomical Society has undertaken to supply the slips requisite for indexing the literature in human anatomy published in Great Britain and Ireland for the International Catalogue of Scientific Literature, which has been set on foot under the auspices of the Royal Society. For this purpose a committee has been appointed, consisting of Prof. Thane, Dr. Arthur Robinson, and the secretary of the Society (Dr. A. Keith).

AT the recent conference of German biologists, held at Berlin, says the *Athenaeum*, a resolution was passed calling the attention of the Imperial Government to the importance of establishing five floating stations on the Rhine for the purpose of biological investigation. Great stress was laid on the practical advantages which pisciculture would derive from these establishments, and it was resolved that if the Government failed to provide the necessary funds, an appeal should be made to the States of Baden, Bavaria, Alsace-Lorraine, Hesse and Prussia.

THE lectures at the Royal Institution of Great Britain will be resumed on Tuesday, February 5, when Prof. J. A. Ewing will deliver his third lecture on "Practical Mechanics (Experimentally Treated)—First Principles and Modern Illustrations"; and on Wednesday, February 6, Prof. R. K. Douglas will deliver his second lecture on "The Government and People of China." The Friday Evening Discourse, on February 8, will be delivered by Prof. G. H. Bryan, his subject being "The History and Progress of Aërial Locomotion."

WE learn from the *Times* that the question of the protection of Stonehenge from further damage was discussed at a recent meeting of the council of the Society of Antiquaries, when a resolution was passed offering to co-operate with the owner of this ancient monument, Sir Edmund Antrobus, for its protection, and suggesting that a scheme might be arranged with that object in view. A copy of the resolution has been forwarded to Sir Edmund Antrobus, and his reply will be considered at the

next meeting of the Society. The general opinion in Salisbury and district is that Stonehenge ought to be purchased by the nation, but the price which was mentioned some time ago is regarded as too great.

THE Right Hon. R. W. Hanbury, M.P., President of the Board of Agriculture, has appointed a committee for the purpose of conducting experimental investigations with regard to the communicability of glanders under certain conditions, and as to the arresting and curative powers, if any, of mallein when repeatedly administered. The committee will consist of:—Mr. A. C. Cope, chief veterinary officer of the Board of Agriculture (chairman); Prof. J. McFadyean, principal of the Royal Veterinary College; Mr. William Hunting, one of the veterinary inspectors of the London County Council; Mr. J. McIntosh McCall, assistant veterinary officer of the Board of Agriculture. Mr. A. H. Berry, of the Board of Agriculture, will act as the secretary to the committee.

IT is proposed in Dundee to erect a granite monument over the grave of James Bowman Lindsay, in the Western Cemetery of the city. Lindsay was a very remarkable man, whose memory should not be permitted to fade. He was born in 1799, and taught electricity, magnetism and other subjects in Dundee for many years, dying there about forty years ago. In 1834 he foresaw that "houses and towns will in a short time be lighted by electricity instead of gas, and machinery will be worked by it instead of steam." This prediction was the result of his own observations of effects produced by the electric current, and not merely imaginative suggestions. In 1854 Lindsay transmitted telegraphic signals through water electrically; and when the British Association visited Aberdeen in 1859, he demonstrated the success of his method by transmitting signals across the harbour. He also read a paper upon it, entitled, "Telegraphing without Wires." Sir John Leng has set on foot the scheme to commemorate the genius of Lindsay by a suitable memorial, and there should be no difficulty in raising the modest amount required for that purpose.

ON Saturday night and Sunday last the metropolis, and indeed all parts of the British Islands, were visited by a storm of great severity. The storm approached from the Atlantic so rapidly that very little notice of its appearance was visible a few hours previously. On Saturday morning the centre of a large depression which had passed to the north of Scotland lay over the north of Sweden, and the only indication of the approach of another serious disturbance was that the wind in the south-west of Ireland showed no inclination to veer beyond west. But the telegraphic reports received by the Meteorological Office showed that in the course of Saturday night the wind had rapidly increased, and on Sunday morning the centre of the storm lay near the north of Scotland. Its influence was felt as far as the south of France, and without doubt far to the north of Scotland. The gusts were very violent, and caused much damage to trees and buildings, the pressure at Greenwich amounting to 34·4 lbs. on the square foot about noon on Sunday, which is equivalent to force 11 of the Beaufort notation. By Monday morning the centre of the disturbance lay over the Baltic, but the interruption to telegraphic communication was so great that scarcely any reports from Northern Europe reached this country in time to be available for the ordinary weather forecasts. Smart showers of hail, snow and rain occurred in most parts of the country.

THE Shanghai Meteorological Society has published its seventh annual report, containing much useful information relating to the atmospheric conditions and movements in the far East. As an appendix to the report an atlas is published showing the mean isobars and the mean directions of the wind for each of the six winter months. The number of stations in the Chinese Empire is too limited to allow of precise information being given, but all that was available, relating to the sea and adjacent shores, has been collected and carefully collated. The average number of storms varies from two in October to four in November, December and January, and five or six in February and March. The general direction of the storm track is E.N.E. with a tendency to bend to N.E. The violence of the storms seldom attains the intensity of a true hurricane; force 10 or 11 of the Beaufort scale is seldom recorded. The report is drawn up by the Rev. A. Froc, S.J., director of the Zi-ka-wei Observatory.

MR. W. MCDOUGALL contributes to *Mind* (January 1901) some new observations in support of Thomas Young's theory of colour-vision. The author has attempted a re-examination of the fundamental and comparatively simple phenomena of vision, and he describes in some detail certain phenomena which he designates "the complete fading of visual images" and "the mutual inhibitions of visual images." The author is unaware of any previous mention of these phenomena, and he applies the knowledge derived from their study to an exhaustive examination of the question of a separate black-exciting process, comparable to the processes that excite the sensations of colour. It is shown that the assumption of such a process is unnecessary and groundless.

A SHORT time ago we noticed a paper, by Signor C. Viola, on the law of rationality of indices in crystallography. A much more exhaustive examination of the actual basis of the thirty-two classes of crystals is now given by Mr. William Barlow in the *Philosophical Magazine* for January. Mr. Barlow's proofs are based on the fundamental assumption of a molecular structure combined with a suitable definition of homogeneous structure. This definition implies the existence of points distributed evenly at regular intervals through the mass, such that the aspect of the structure, viewed from all such corresponding points, is the same, but that an inferior limit to the distance between corresponding points always exists. The method of arriving at the thirty-two classes combines some of the arguments used by Sohncke with some of those used by Gadolin and others, and the paper includes a discussion of Haüy's law.

SOME new experiments by M. G. Sagnac on the transformations of Röntgen rays by matter are summarised in No. 157 of the *Bulletin* of the French Physical Society. The study of the electric action of the secondary rays emitted by a body affords a test of the presence of small quantities of relatively active substances such as copper, iron, aluminium. Hence, also, a method of searching for new elements. The energetic absorption of the more active rays from such a metal as platinum in the first few millimetres of adjacent air has been verified directly by rarefying the air surrounding the metal. Finally, a pencil of Röntgen rays discharges a conductor even when it does not pass through the portion of air acted on by the electric field of the conductor. It is sufficient that the rays shall traverse a portion of air separated from the field of the conductor by a Faraday screen (such as a metal gauze), and that there shall be a field of force in the part traversed, of like sense to that due to the conductor. If the charge of the conductor is reversed in sign, the rate of discharge is altered in the ratio of 1 to 10 or 20, but in the absence of the field in the second region no such change takes place. M. Sagnac's explanation of the phenomena is that the ions produced in the second region acquire, under the influence of the external field, sufficient kinetic energy to carry them through the openings of the screen into the region surrounding the conductor.

THE melting-point of gold is an important fixed point in pyrometry, and its exact determination has been attempted by several observers. In this country the electrical resistance pyrometer has been regarded as the most trustworthy instrument, the mean result obtained by its use being given by Messrs. Heycock and Neville as 1061·7° C. In the January number of *Wiedemann's Annalen* there is a further paper on this subject by Messrs. L. Holborn and A. Day. These observers prefer a thermo-couple that has been directly standardised against an air thermometer as their measuring instrument. In their previous papers these authors have described a method in which the melting-point of a small piece of gold wire is determined. On account of the possibility of the result being influenced by the minute amount (·03 gram) used, it appeared desirable to redetermine the constant by the crucible method. The temperature of 450 grams of solidifying gold was measured with a thermo-couple in crucibles of graphite, porcelain and clay, the atmosphere above the fused metal being either air, carbon dioxide, or oxygen. The mean result was 1063·5° C. The same sample of gold gave 1063·9° C. by the wire method.

THE Board of Trade has received, through the Foreign Office, copy of a memorandum by H.M. Consul at Milan respecting an electrical smelting process carried on in North Italy under Captain Hassano's patent. The memorandum states that the feature of Captain Hassano's process is the substitution, in the smelting of iron ore, of heat produced by electricity for that produced by coal, and the merit he claims for it is economy. His experiments were begun in Rome, but have now for some time been carried on, under his personal superintendence, by a company formed for the purpose, at Darfo, in the Province of Brescia, where a considerable water-power is available. At the end of last month a commission composed of five well-known scientific men spent two days at Darfo and witnessed a series of experiments. These gentlemen have now issued a very brief report to the effect that they consider the Hassano process to be industrially practical. The Consul states, however, that he has consulted several very competent authorities at Milan who have carefully followed the development of Captain Hassano's invention, and they are all of opinion that as yet no adequate proof has been furnished that the new system will not cost more rather than less than the one actually in use. Moreover, its application, with any prospect of success, appears to be dependent on the possession of a very abundant water-power, at a very low price, for the production of the electric energy, the consumption of which is enormous.

MR. J. B. C. KERSHAW'S paper on "The Use of Aluminium as an Electrical Conductor," which was read before the Institution of Electrical Engineers on January 10, contains an account of some interesting experiments made by the author on the durability of aluminium under different atmospheric conditions. The results show that the commercial aluminium at present obtainable is by no means perfectly resistent to atmospheric corrosion, but becomes seriously pitted after ten months' exposure, especially in the air of towns. Unfortunately the scientific value of the experiments is diminished by the fact that, although the aluminium used had only a purity of 99 per cent., no analysis of the samples was made. According to Moissan, pure aluminium is quite stable, but the presence of a very small quantity of sodium destroys this stability. It is to be hoped that Mr. Kershaw, in his further experiments, will carry out a more thorough investigation of this point, as it is one of great importance. The paper shows how enormously aluminium has decreased in cost in the last ten years, until it has now become, by virtue of its cheapness, a formidable rival to copper. Some interesting details are given of aluminium transmission lines which have been, or are being, erected in America, which show that country to be far in advance of England in this, as in most other, enterprises.

IN the *Victorian Naturalist* for December Messrs. Fulton and Grant record the occurrence of the European shore-crab (*Carcinus moenas*) in considerable numbers in Port Phillip. If, as seems probable, the species is introduced, it is the first instance of the intrusion of a European marine type into the Australian fauna, and the progress of the intruder will be watched with interest. To the same number Mr. D. le Souëf contributes notes on some little known Australian birds' eggs.

IN the January number of the *Zoologist* Mr. T. Southwell, of Norwich, describes a recent visit to the fish-wharf at Lowestoft, in the course of which he shows how much information is to be gleaned with regard to our fish-fauna from such an inspection. Among the uncommon captures was a porbeagle shark nearly eight feet in length. The author adds that all the animals seen at Lowestoft must not be regarded as British, mentioning the case of the so-called prawns of the genus Nephrops, large numbers of which are brought in from the North Sea.

To the same journal Mr. G. Leighton contributes an account of an extraordinary "plague" of snakes which has recently occurred in a house at Cefncaeau, near Llanelly, South Wales. During September, according to a newspaper report, the place had become a domicile for swarms of these reptiles. "They crawled over the floors, infested the cupboards, curled themselves together on the furniture, while some more aspiring members of the species climbed the stairs and luxuriated in the comforts of the bedrooms. The human occupants of the house had done their best to rid themselves of these unwelcome visitors, and had waged a war of extermination against them. The snakes continued to come, however, although, as the inspector explained, no fewer than twenty-two were slaughtered in one day." As might have been expected, the species proved to be the common grass, or ring-snake. The eggs from which the twenty-two individuals mentioned above were hatched were probably deposited by the parent behind the oven, or in a hole in the back wall. On taking down a portion of the latter wall no fewer than forty bunches, each containing thirty eggs, were discovered, all being on the point of hatching. There were thus some twelve hundred snakes in an area of a few square feet.

THE December issue of the *Agricultural Journal* of New South Wales contains the conclusion of an interesting communication by Mr. W. J. Allen on olive culture in the Colony, illustrated with seven plates showing the fruit of the various varieties that have been raised there. The author lays great stress on the importance of cultivating only such varieties as have been proved to be suitable to the Australian climate and soil, and are, at the same time, noted for their abundant yield of oil. How great is the difference in the latter respect between different strains is shown graphically by photographs of a series of equal-sized flasks containing the products of equal quantities of olives. In the case of two varieties the yield is a flask and a half, or more, whereas some of the inferior strains yield not more than one-sixth of a flask.

WE have received the fifth of the excellent series of *L.M.B.C. Memoirs* now in course of issue under the able editorship of Dr. Herdman, the present fasciculus, which is by Dr. Hickson, dealing with *Alcyonium*, the zoophyte commonly known as "dead men's fingers." The anatomy, development and physiology of this curious compound form are severally treated in considerable detail, the whole account forming a model of how such a subject should be treated. When an Alcyonium colony has all its polyps fully protruded, the whole

organism is in a state of activity; but this could not go on incessantly, and the periodical retraction of the polyps seems to mark intervals of rest. These periods of rest and activity appear to be correlated, not with night and day, but with low and high tides; and it seems probable that Alcyonium takes a rest at each low tide, that is, twice in every twenty-four hours. Owing, however, to the unsatisfactory conditions obtaining in aquaria, it has not yet been found possible to ascertain the duration of these periods of repose in a state of nature. The author adds that in a large fleshy mass like Alcyonium it is obvious that there must be some general system of circulation, and in the absence of rhythmically contractile organs it is equally obvious that such circulation must be maintained by ciliary action.

MUCH interesting and important information with regard to food-fishes is afforded by the Report of the Northumberland Sea-Fisheries Committee for 1900, edited by Mr. A. Meek. The flat-fishes, collectively, give an average of 231 in the "takes," which is a considerable improvement over the previous year; but this is almost entirely due to an increase in the number of dabs, plaice having diminished to a marked degree, while turbot have, unfortunately, become exceedingly rare along the coast. It is, however, gratifying to notice that the catch of soles shows a slight improvement over those of the two previous years. Very few floating eggs were obtained, the explanation being that the work was done in harbour during summer, and that the fringe of water near the coast is also the fringe of the great area of water outside where the spawning and hatching take place. A short statement by Prof. Brady is made with regard to the pelagic fauna obtained with the eggs, while Mr. Bulman treats of the molluscs, and the editor of the shrimp-like mysids and the curious crustaceans included under the name Cumacea. These latter may seem to have but a remote connection with fisheries; but as they contribute, directly or indirectly, to the food of fishes, crabs and lobsters, their inclusion in the Report is fully justified. The results of the hatching experiments conducted during the early part of the year show that the work of the fertilisation of the ova of ripe fishes caught by the trawlers must be done at sea soon after the capture of the fishes. An experiment in mussel cultivation has been undertaken, the results of which will be published in the next Report.

A FEW particulars concerning the bird-catching industry in the Faroe Islands are given in the *Board of Trade Journal* (January 24). Among the various species which make the isles a country of birds, the following may be specially mentioned: the guillemot, the auk, the puffin and the kittiwake. During a certain part of the summer they appear in such numbers on and around the "fowling cliffs" as to suggest resemblance to a thick snow-storm of living winged creatures. In the Faroe Isles a "fowling cliff" means a perpendicular cliff, the numerous shelves of which are covered with guillemots and auks. The puffin and the kittiwake are also often found here, but not necessarily always. The "fowling cliffs" all face towards the west—that is, from south-west to north-west. There are also perpendicular cliffs facing towards other points of the compass, but scarcely any birds are found on these. The puffin is the most important bird in the islands, and about 100,000 are caught annually. Twenty-four of these birds yield one pound of feathers. A few years ago a number of grouse were let loose on the islands, and it appears that they have thriven well on some of the northern isles, where several flocks may be seen.

A TRIPLE horizontal pendulum of the Rebeur-Ehlert type has recently been erected for the study of earthquakes at Hamburg. Dr. R. Schütt, who has charge of the instrument, has published the first of a series of monthly *Mittheilungen*, dealing with the earthquakes registered during October 1900.

IN a short paper contributed to the Roumanian Academy, and published in vol. xxii. of the *Analele*, Dr. S. C. Hepites describes the Roumanian earthquakes of 1899. They were all of slight intensity, and occurred on January 12, August 6 and 9, October 10, November 13 and December 20.

MR. JAMES MCEVOY reports on parts of Alberta and British Columbia (Geol. Surv. Canada, *Ann. Rep.*, part D, vol. xi, 1900). His observations were made in a traverse of the Yellow Head Pass route from Edmonton, on the North Saskatchewan river, to Tête Jaune Cache. Rocks of Archæan, Cambrian, Devono-Carboniferous, Cretaceous and Tertiary ages are recorded, as well as Glacial and other superficial deposits. Gold is noted in the Lower Cambrian areas, and some thick seams of coal in the Lower Laramie (Cretaceous) strata.

DR. J. F. WHITEAVES contributes descriptions of some new and imperfectly-known fossils from the Cretaceous rocks of the Queen Charlotte Islands (Geological Survey of Canada, "Mesozoic Fossils," vol. i. part 4, 1900). As he remarks, the progress of palæontological research during the fourteen years which have elapsed since the third part of his work was published, necessitates alterations in nomenclature. A fossil was previously identified as *Ammonites Beudanti*, and placed in the genus *Haploceras*: since then the Ammonite has been regarded as a *Desmoceras*, and more recently it has been referred to the subgenus *Puzozia*. Dr. Whiteaves deems it prudent to give the Canadian fossil a new specific name, so the Ammonite now stands as *Desmoceras* (*Puzozia*) *Dawsoni*. This is a good illustration of the heartrending though needful changes brought about by the detailed study of fossils. A number of new species of Mollusca and Brachiopoda are now described and figured by Dr. Whiteaves. One British species, *Inoceramus concentricus*, is recorded.

AUSTRALIA offers a wide field of work for those experienced in the industrial utilisation of vegetable products. Although the practical value of economic botany remains imperfectly understood throughout the Commonwealth, there are not wanting indications of its approaching recognition as a new and valuable source of national wealth. Recently, in New South Wales, Mr. R. T. Baker, the curator and economic botanist of the Sydney Technological Museum, appeared as a witness before a Royal Commission appointed to inquire into the condition of the western lands of the State. In the course of his examination he produced samples of eucalyptus oil in various stages, extracted from trees in the eastern portions of New South Wales, and stated that the colony now produces eucalyptus oil of the highest quality, fully equal to the best in the market. He said that a large amount of research has lately been made in connection with the flora of that part of the parent State, with very valuable results. For instance, myrticolorin, a new dyeing material, has been obtained from the leaves of the red stringy bark, in addition to the valuable oil extracted from the same source. Out of trees and shrubs in the eastern portion of the State, Mr. Baker has, with the assistance of his staff, extracted camphor, perfumes (such as otto of roses, ionone and cinnamon), dyes, peppermint and cajuput—oils which ought now to be pushed on the market. New South Wales can also compete against India and Bulgaria with its geraniol extract. Mr. Baker's evidence went to show that the vegetable products of the western, or dry country, in New South Wales, possesses an economic value not inferior to those of the eastern or coastal districts. It may be mentioned that there are in the west, as in the east, many millions of eucalyptus trees of various

kinds, the trees and shrubs from which oils, resins, dyes, tans and other products can be obtained being several hundred in number.

THE current number of the *Proceedings* of the Royal Society contains a paper of much interest to all who are devoted to the canine race. It describes Dr. Copeman's successful endeavours to isolate the micro-organism responsible for distemper in dogs. The investigations here recorded are a continuation of work begun some ten years ago by the late Everett Millais at St. Thomas's Hospital. Dr. Copeman has now isolated a small cocco-bacillus, growing readily on most of the ordinary culture media at the body temperature, from the exudations from the lungs, the tracheal mucus, and from the nasal secretion of dogs suffering from distemper. A cubic centimetre of a broth-culture of this microbe, injected beneath the skin of the abdomen in a dog weighing 7 kilograms, is sufficient to induce an attack of distemper terminating fatally in about a week from the date of inoculation. A vaccine has also been prepared which Dr. Copeman states can protect dogs against attacks of distemper. This vaccine is procured by heating a broth culture of the bacillus at 60° C. for half an hour, and then adding a small quantity of carbolic acid. An injection of 2 cubic centimetres of such vaccine was apparently sufficient to protect fox-terrier pups weighing about $1\frac{1}{2}$ kilograms when exposed to distemper infection. How long this immunity is retained by dogs has not yet been ascertained, but information on this and other important points connected with this discovery may shortly be expected, as Dr. Copeman tells us that a series of tests on a large scale are in process of being carried out by dog-breeders in this country, as well as in Germany and America.

WE are very favourably impressed with the first number of the *Journal of Hygiene*, which has just been issued. Messrs. Nuttall, Cobbett and Strangeways-Pigg contribute a paper, illustrated with maps, on the geographical distribution of *Anopheles*, the malarial mosquito, in England, and Messrs. Nuttall and Shipley the first part of a paper on the structure and biology of the same insect. Species of *Anopheles* seem to have been met with in all the districts examined, and not only in those where malaria was formerly prevalent. Dr. Klein, dealing with the pathogenic microbes of milk, has found the tubercle bacillus to be present in 7 per cent. of the samples examined, a figure which accords well with our own experience. Dr. Legge discusses industrial lead poisoning, and Dr. Newsholme the utility of isolation hospitals in diminishing the spread of scarlet fever. Dr. Haldane describes an apparatus for the rapid determination of carbonic acid in air. The apparatus is quite portable (the inclusive weight being only about six pounds), and has an accuracy of 0·5 vol. per 10,000. Dr. Haldane also contributes a paper on the red colour of salted meat, and finds it to be due to nitric-oxide-hæmoglobin. This is formed by the action of a nitrite on hæmoglobin in the absence of oxygen and in the presence of reducing agents, the nitrite resulting from the nitre in salting by reduction, probably through the agency of bacteria. When boiled it is changed into nitric-oxide-hæmochromogen. Messrs. Lorrain Smith and Hoskins find that ethylene does not contribute to the poisonous action of coal gas. Dr. Ritchie discusses the artificial modifications of toxins under the influence of acids and alkalies. The *Journal*, which is edited by Drs. Nuttall, Haldane and Newsholme, is to be issued quarterly, and is published by the Cambridge University Press. The present part is illustrated with figures and diagrams in the text, with a double plate illustrating the structure of *Anopheles*, and with a beautiful coloured plate of *A. Maculipennis*.

THE *Reliquary and Illustrated Archaeologist* has its usual well-illustrated articles on various matters of antiquarian interest. We need only call attention to a paper by Mr. W Heneage Legge on some churches in the Hundred of Willingdon in Sussex; one by Mr. J. K. Floyer on "A thousand years of a Cathedral Library" (Worcester). Miss Florence Peacocke draws attention to needlework maps, which were sometimes veritable works of art. John Schorne, a mediæval worthy, is the subject of a paper by Mr. T. Hugh Bryant. This popular preacher of the early fourteenth century was accredited a saint by public opinion because he "conjured the devil into a boot." This may be the origin of the popular tavern sign "The Boot," and may also have given rise to the toy known as "Jack-in-the-box."

IT has been stated that the inhabitants of the Mentawei Islands, which lie off the west of the coast of Sumatra, are more nearly allied to the Polynesians than to the Malays; but in a beautifully illustrated account of these islanders in *Globus*, Mr. C. M. Pleyte denies this resemblance, in which he is certainly corroborated by the illustrations, and states that they are allied to the Battak. Mentawei is derived from the Malay *matäu*, "man," pronounced locally *matawi*. The natives call themselves Tschakalägät. The men and women are tattooed in straight and slightly curved lines, and occasionally bird designs, on various parts of the body, but the men are more ornamented than the women; it is a necessary preliminary to marriage. It is interesting to note the bow and arrow is employed; the arrows used in warfare are poisoned; the blow-pipe is unknown. The religion appears to be shamanistic; men and women may be shamans (Pleyte terms them "priests"). There are numerous prohibitions, or taboos (*punän*). Divination is performed by an examination of the viscera, especially the stomach, of pigs and fowls. The paper is a valuable record of the ethnography of a people practically unaffected by external influence.

THE Canadian Institute could not have chosen a more appropriate way of commemorating the first fifty years of its history than by the publication of the fine memorial which forms vol. vi. of the *Transactions* of the Institute. The papers in the volume cover a wide field of scientific activity, and do honour to Canada. Sir Sandford Fleming, who was the first secretary and the real founder of the Institute, should be gratified at its growth and influence. The Institute has encouraged scientific study and investigation, and their applications to practical results. It has placed a vast amount of varied knowledge at the disposal of the public, and its recommendations have for many years been received with respect in the official as well as the scientific worlds. One subject of great interest, which first engaged the attention of the Institute twenty years ago, and with which the name of Sir Sandford Fleming is prominently associated, is the zone system of time-reckoning. On the action taken by the Institute, a discussion was inaugurated which extended eventually to Great Britain, and afterwards to all civilised nations, with the result that the essential principles of the system recommended have been adopted on all the five continents. Countries are being brought into the zone system one by one, even though all of them have not adopted the twenty-four hour notation. In other matters the Institute has taken the lead, and has contributed in no small degree to the increase of knowledge in letters, art and science in the Dominion of Canada. We can only mention a few of the subjects dealt with in the volume, namely, the geological history of Lake Superior, the decipherment of the hieroglyphic inscriptions of Central America, the magnetic influence of the sun on the earth and on comets, the structure, microchemistry and development of nerve-cells, the cytology of non-nucleated organisms, the anatomy of the orang-outang, and the morphology of the central cylinder in the angiosperms.

THE following lectures will be delivered during February at the Royal Victoria Hall, Waterloo Road, at 8.30 p.m. :—February 5, "Germs, Our Friends and Foes," by Mr. J. E. Purvis; February 12, "The Eastern Hemisphere," by Mr. E. J. Garwood; February 19, "An Old English Chemist of the Seventeenth Century," by Dr. Donnan; February 26, "Life of the Natives of Sarawak," by Prof. Haddon.

THE new volume of "The Englishwoman's Year Book and Directory for 1901" (A. and C. Black) has been overlooked until now. The value of this annual lies in the fact that it is a guide to spheres of activity open to women, and a summary of women's contributions to intellectual progress during the past year. The scientific summary is not complete, but it serves to show that women are assisting in the advancement of many departments of natural knowledge.

THE only journal in the world devoted entirely to the study of ophthalmological refraction is the *Dioptric and Ophthalmometric Review*, published for and by the Council of the British Optical Association. In addition to the articles, abstracts and notes of special value to opticians, the review contains contributions of interest to all students of optical science. We notice, for instance, descriptions of recent optical patents, and the questions set at the examination of the British Optical Association in December.

THE additions to the Zoological Society's Gardens during the past week include three Martinican Doves (*Zenaida aurita*) from the West Indies, presented by Mr. D. Seth Smith; a White-backed Piping-Crow (*Gymnorhina leuconota*) from Australia, presented by Miss Crowder; a Peregrine Falcon (*Falco peregrinus*), European, presented by Mr. Alfred Ficken; a Greater Black-backed Gull (*Larus marinus*), European, presented by the Hon. Mrs. Barnett; a Himalayan Monkey (*Macacus assamensis*) from Northern India, a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, a Two-spotted Paradoxure (*Nandinia binotata*), a Grey Parrot (*Psittacus erithacus*), a Shining Weaver Bird (*Hypochera nitens*) from West Africa, a Barbary Wild Sheep (*Ovis tragelaphus*) from North Africa, a Barbary Falcon (*Falco barbarus*) captured in the Red Sea, nine Ceylonese Terrapins (*Nicoria trijuga*) from India, deposited; a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*) from Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY.

Feb. 1. 6h. 32m. to 7h. 18m. Moon occults D.M. + 17°, 1596 (mag. 5·6).
2. 17h. 20m. to 17h. 42m. Moon occults A¹ Cancri, (mag. 5·6).
2. 18h. 57m. to 19h. 47m. Moon occults A² Cancri, (mag. 5·8).
3. 14h. 34m. to 15h. 37m. Moon occults ω Leonis, (mag. 5·6).
9. 17h. 38m. to 18h. 53m. Moon occults B.A.C. 4700 (mag. 5·3).
14. Venus. Illuminated portion of disc = ·949, of Mars = ·997.
14. Saturn. Outer minor axis of outer ring = 15″·08.
14. 17h. Jupiter in conjunction with the moon. Jupiter 2° 51′ S.
14. 19h. 7m. Jupiter's Satellite IV. in conjunction N. of the planet.
15. 11h. 20m. Minimum of Algol (β Persei).
18. 8h. 9m. Minimum of Algol (β Persei).
19. 10h. Mercury at greatest elongation, 18° 6′ East.
20. 1h. Mercury in conjunction with the moon. Mercury 3° 29′ S.
21. 6h. 54m. to 7h. 51m. Moon occults 51 Piscium (mag. 5·7).
21. 18h. Mars in opposition to the sun.
22. 10h. 20m. to 11h. 7m. Moon occults π Piscium (mag. 5·6).
24. 16h. 20m. to 19h. 13m. Transit of Jupiter's Satellite III.

BROOKS' MINOR PLANETS.—Referring to the recent note in NATURE (January 3) announcing the discovery of three new minor planets near to Eros, Herr Kreutz publishes, in the current issue of the *Astronomische Nachrichten*, Bd. 154, No. 3682, a telegram from Prof. E. C. Pickering, of Harvard College, saying: "Brooks' asteroids not confirmed on simultaneous plate; stars near position given."

BRORSEN'S COMET.—In the *Astronomische Nachrichten* (Bd. 154, No. 3681), A. Berberich gives an ephemeris to facilitate the search for the expected return of Brorsen's Comet this year.

Ephemeris for 0h. Berlin Mean Time.

1901.	R.A. h. m. s.		Decl. ° ′
Feb. 1	18 59 8	...	+ 6 11·4
3	54 12	...	7 15·3
5	50 14	...	8 7·4
7	47 6	...	8 49·9
9	44 39	...	9 24·7
11	42 48	...	9 53·5
13	18 41 26	...	+10 17·4

EPHEMERIS FOR OBSERVATIONS OF EROS.

Ephemeris for 12h. Berlin Mean Time.

1901.		R.A. h. m. s.		Decl. ° ′ ″		Mag.
Feb. 1	...	3 43 52·25	...	+24 52 16·6		
3	...	51 13·94	...	24 3 56·7	...	8·6
5	...	3 58 38·03	...	23 16 0·1		
7	...	4 6 3·97	...	22 28 28·6	...	8 6
9	...	13 31·30	...	21 41 24·2		
11	...	20 59·64	...	20 54 48·9	...	8·7
13	..	28 28·61	...	20 8 44·7		
15	...	35 57·91	...	19 23 13·0	...	8 8
17	...	43 27·24	...	18 38 15·7		
19	...	50 56·35	...	17 53 54·5	...	8·8
21	...	4 58 24 94	...	17 10 10·4		
23	...	5 5 52·72	...	16 27 4·3	...	8·9
25	...	13 19·36	...	15 44 37·2		
27	..	5 20 44·55	...	+15 2 49·5	...	8·9

ELLIPTIC ELEMENTS OF COMET 1900 *c*.—Herr H. Kreutz has computed the following elliptic elements of Giacobini's Comet (1900 *c*) from the determinations of position made on 1900 December 24, 28, and 1901 January 14. (*Astronomische Nachrichten*, Bd. 154, No. 3682).

Epoch 1901 *Jan.* 14, *Berlin Mean Time.*

$$\begin{aligned} M &= 6^\circ\ 45'\ 47''\cdot0 \\ \left.\begin{aligned} \omega &= 171\ \ 29\ \ 10\cdot6 \\ \Omega &= 196\ \ 32\ \ 33\cdot8 \\ i &= 29\ \ 52\ \ 16\cdot9 \end{aligned}\right\} & \ 1901\cdot0 \\ \phi &= 47\ \ 52\ \ 35\cdot5 \\ \mu &= 551''\cdot914 \\ \log a &= 0\cdot558287. \end{aligned}$$

The following ephemeris by J. Möller is given in the same journal:—

Ephemeris for 12h. Berlin Mean Time.

1901.		R.A. h. m. s.		Decl. ° ′		Br.
Feb. 2	...	2 22 4	...	−18 11·6	...	0·32
6	...	2 37 29	...	17 9·6	...	0·28
10	...	2 52 10	...	16 6·4	...	0·24
14	..	3 6 10	...	15 3·0	...	0·21
18	...	19 33	...	13 59·8	...	0·19
22	...	32 21	...	12 57·5	...	0·17
26	...	3 44 40	...	−11 56·8	...	0·15

Observations of the Comet by R. G. Aitken with the 36-in. Lick refractor showed it as irregular in outline, with a condensation south—preceding the centre, and a small fan-shaped extension in the north—following quadrant.

REFRACTION WITHIN TELESCOPE TUBE.

IT has been supposed that the difference between the zenith-distance of a star obtained by direct observation and that obtained by observing it reflected in a pool of mercury—as it is not fully explicable as the result of the flexure of the telescope-tube—is partly to be accounted for as the result of abnormal refraction in the neighbourhood of the instrument, owing to varying air-temperatures in the room. It is *within the tube of the instrument* that these things are to be looked for.

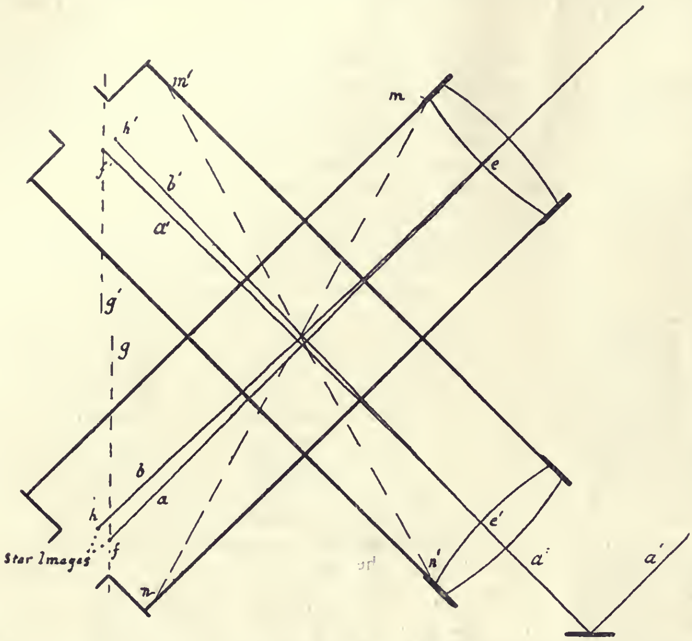


Fig. 1.—*a*, *a'*, Rays normally refracted by horizontal stratification of air. *b*, *b'*, Rays refracted by stratification of air parallel to *mn*, *m'n'*, (inverted refraction). *mn*, *m'n'*, Equal-density surfaces when upper side of tube is cooled.

The air within a room where there is no powerful source of heat and where currents are caused by open shutters, &c., must be very nearly uniform in temperature; neither would it prove the contrary to obtain varying readings of the thermometer within the room, such readings being much affected by radiation from the walls, &c. On the other hand, the air within the telescope-tube must commonly be stagnant, and any cause operating to produce differences of temperature therein will do so effectually. Now in making any observation at considerable zenith distance the upper side of the tube is cooled by radiation, while the lower is protected, and the resulting difference of temperature in the metal of the tube is communicated to the air within, to an extent depending on the time of exposure.

In the diagram (Fig. 1) showing the telescope in the two positions of observing—direct and reflex—the rays *a*, *a'*, are normally refracted and convex upwards, as they would be with horizontal stratification of the air. At any two points at the same level these rays (supposed from the same star) have the same inclination to a vertical line; therefore the zenith distances that would be observed with such refraction (angle *e*, *f*, *g* direct and *e'*, *f'*, *g'* reflex) would be the same—neglecting flexure and the difference of latitude between the trough and instrument. But this result depends on the supposed parallel (viz. horizontal) stratification of the air throughout the course of both rays. When there is a transverse gradient of temperature in the tube owing to the cooling of its upper side and the contiguous air within, the equal-density surfaces are inclined like *m*, *n*, *m'*, *n'*—a difference of temperature of only two-tenths of a degree Fahrenheit will make the air at *m* as dense as it is at *n* if these points differ in level by ten feet—and the stratification of the air, being no longer parallel in the two cases, two different zenith-distances will be obtained. The rays within the tube will then be convex downwards, *b*, *b'*—"inverted refraction"—and the direct observation will give a result in excess of the reflex one by twice the angle *f e h*. So if the results were only affected by this process the Reflex-minus-Direct results would be ***negative***. The R – D results obtained in the Greenwich observations are commonly *positive* by reason of the flexure of the tube, and are *reduced in magnitude* by inverted refraction.

In the diagram (Fig. 2) the curve *a* shows the R – D results that would be obtained if affected by instrumental flexure only; from the formula 2(0″·80 sine zenith distance). This value 0″·80 I take to be nearly the correct horizontal flexure (see below). The curve A shows the mean results obtained for the values of R – D in the years 1892–3–4 for south stars, *reflex observation taken first*. The curve B shows the same results for north stars. The curve C shows a special series of R – D results obtained in the year 1894, all from south stars, the direct observation being made first. The differences between these curves severally and the flexure curve *a* are accounted for by the inverted refraction in the tube, and the various values of these differences for the three curves are readily explained:—

(*a*) The north-star-curve differs more from the flexure-curve than the south-star-curve does; the difference in both cases is due to the exposure of the instrument in the position directed to the star (chiefly in the reflex position); but in observing a north star the time of exposure is commonly greater than in observing a south star, as the observation in right ascension is made at the same time, and a slow moving polar star requires more time for this purpose.

(*b*) From Fig. 1 it is apparent that it is at the object-glass end of the tube that the inverted refraction is most effective in separating the star image *h* from the position *f*, where the normal refraction would place it; and of the two observing positions of the instrument, the direct one chiefly affects the object-glass end by radiation, because in this position it is near the open shutter. In the observations from which the curves A and B are deduced,

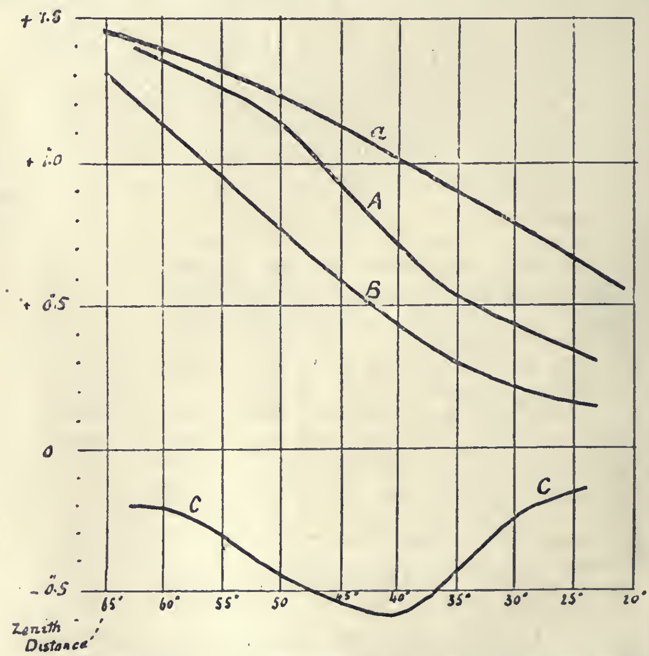


Fig. 2.—*a*, Flexure curve, 2(0″·80 sine zenith distance). A, R – D curve, south stars, reflex observation taken first. B, R – D curve, north stars, reflex observation taken first. C, R – D curve, south stars, direct observation taken first.

the reflex observation is made first, and the instrument is then turned in mid-transit to the direct position, in which the exposure is of very short duration before the observation in zenith distance is made. In the curve C, for which in each case the direct observation was made first, the exposure in the direct position would commonly be considerably greater; and the difference between this and the flexure-curve, attributable to such exposure, is accordingly much greater than the same differences for the A and B curves. Note that the difference becomes smaller under 40° zenith distance; it would be zero in the zenith in all cases.

Other instances of apparent refraction within the tube are found in the Greenwich observations:—

When the north and south collimators are alligned by looking through the holes in the telescope-cube, the collimation-error obtained differs systematically from that obtained by alligning the collimators with the telescope raised out of the way. This can only be explained thus: one side of the instrument is commonly warmer than the other at the hour (8 a.m.) when these observations are made, and the still air in the tube is affected in like manner. If we suppose the air in the spaces A and B, Fig. 3, to differ from each other 0° 5 Fahr. in temperature, and to be separated by a surface which the path of the light between the north and south collimators cuts at an angle of incidence of 80°, the light will be deflected $0''\cdot60$ of arc, and the collimation-error obtained would be in error by half this amount, viz., $0''\cdot30$,

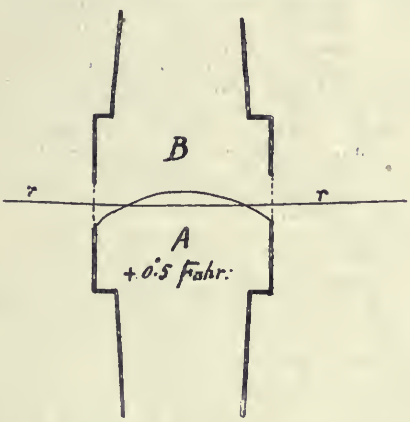


FIG. 3.—r, Shows path of light from north to south collimator refracted within cube of telescope when air is unequally heated.

which is about the difference between the values obtained by the two methods.

A similar discordance exists between the results for flexure of the tube formerly obtained by raising the telescope and those recently obtained by alligning the collimators through the cube; and this discordance has a similar explanation. The flexure obtained formerly, which I take to be the more correct, is about $0''\cdot80$ of arc, as employed above to explain the R – D discordance.

I conclude that means should be provided—and used—for circulating the air in the tube when any observation—whether of star, of collimation, or of flexure, or otherwise—is made with a transit circle. I would also point out that the source of error here considered is of peculiar importance from the fact that it affects, to a relatively large amount, the zenith-distances of polar-stars, and hence the deduced results for latitude. The error is eliminated in the mean of a reflex and a direct observation taken at the same time.

JAMES RENTON.

SUGAR-CANE EXPERIMENTS.

IN the fourth number of the *West Indian Bulletin*, recently noticed in these columns, many pages were devoted to communications to Dr. Morris, the Imperial Commissioner of Agriculture, from Prof. d'Albuquerque, the Island professor of chemistry, and Mr. Bovell, the agricultural superintendent, in which an elaborate plan was laid down for undertaking an exhaustive investigation into the merits of several varieties of sugar-canes. The very full details therein given should be consulted by any one desirous of mastering the significance of the facts contained in the pamphlet now issued by the Commissioner, giving a "summary of the results of the cultivation of seedling and other canes at the experiment stations in Barbados in 1900." Prof. d'Albuquerque and Mr. Bovell have read a paper on the subject before the Barbados Agricultural Society on the results of the cultivation and yield of selected seedling and other canes, and the pamphlet summarises the essential facts. It is important to remember that the experiments were throughout conducted on the ordinary system of natural cultivation, the planters themselves undertaking to set apart plots of their own plantations, so that the known and the unknown grew side by side, no exceptional treatment being recognised. In this way fairly typical results are obtained, and the results for subsequent years will, therefore, be watched with more than usual interest to see how the character of the season, as well as the quality of the soil, may affect the various canes. For the experiments seven stations were selected, representing the typical soils and climatic conditions of Barbados. Five of the stations were black soil, the other two red soil. At nearly every station there were duplicate plots of each variety, serving to show the variation to be expected with each variety from one part of the field to another. The lowest station was at an elevation of 100 feet above sea-level, the highest 910 feet, the rainfall in the growth period ranging from 56 inches to 89 inches. Fifteen selected varieties of canes were tested on the black soil estates, and ten of them on the red soil estates. For each variety the highest and the lowest yield in tons per acre in the black and the red soils respectively are given, and separate tables for black and red soils show for each cane the number of plots used for the investigation, the yield in tons per acre of canes and also of tops; the juice per cent. by mill; pounds per gallon of saccharose, of glucose and of solids not sugar; the quotient of purity of the normal juice; the juice in gallons per acre; saccharose in pounds per acre; and the sugar in tons per acre, calculated according to a formula supplied by Mr. Douglas, of the Diamond plantations, British Guiana. In the black soil B. 147 heads the list with 3·01 tons of sugar per acre, followed by B. 347 with 2·90 tons, and B. 208 with 2·83 tons, while at the bottom of the list stand D. 145 with 1·82 tons, the Burke with 1·73 tons, and the Bourbon with only 0·47 ton per acre. The White Transparent cane, which is cultivated in Barbados on a larger scale than any other cane, and may therefore be regarded as the standard for comparison. occupies a middle place with a yield of 2·41 tons per acre. In the red soil B. 208 takes first place with 3·34 tons per acre, followed closely by B. 156 with 3·32 tons and B. 147 with 3·31 tons, the lowest being B. 347 with 2·17 tons and B. 254 with 2·14 tons.

The mean results for both soils indicate B. 147 to be the best all-round cane, its yield being 27·52 tons of canes per acre, 3·1 tons of sugar and 6291 lbs. of saccharose, B. 208 occupying second place with respectively 22·55 tons, 3·02 tons, and 5443 lbs., compared with the standard White Transparent results of 20·49 tons, 2·41 tons, and 4528 lbs. A further table gives the results obtained on the three estates of "Dodds," "Pine" and "Waterford" with B. 147 and the White Transparent varieties, the means for the three estates giving B. 147 a yield per acre of 6999 lbs. of saccharose and 3·70 tons of sugar, while the White Transparent yielded 4527 lbs. of saccharose and 2·41 tons of sugar. It will thus be seen that the new seedling, B. 147, is better than the standard by more than a ton of sugar per acre. Looking to the individual and general results, the investigators consider there is a satisfactory degree of agreement under a considerable variety of conditions of culture and growth. B. 147 is regarded as the best all round seedling variety as a plant cane in Barbados, B. 208 giving promise of proving a good red soil plant and ratoon cane. Planters are advised to try, on a small scale, three or four of the varieties which have done best in these experiments, so as to be able to secure eventually the cane best suited to the nature of their particular fields and their own methods of cultivation—features which have, in their way, quite as much weight as the character of the cane itself. While B. 147 seems to be the most suitable cane for particular soils in Barbados, D. 95 appears to be the best for the different circumstances of Antigua. A private letter from Barbados, in which reference is made to the above experiments, states that the officials of the Agricultural Department seem determined on securing improved varie es o
that will suit each district, and will yield at least 50 per cent. more sugar than those hitherto cultivated.

TECHNICAL EDUCATION IN MANCHESTER.

IN no English city is a more sensible or more thorough provision for technical education to be found than in Manchester. Whatever standard of comparison is adopted, be it the number of students under instruction in proportion to the population, the amount of annual expenditure, the number of the schools, or the enthusiasm of its administrators and teachers, Manchester will take one of the foremost places in the educational ranks of the country. In some particulars, indeed, Manchester stands almost alone. In the arrangements which the Technical Instruction Committee of its City Council and its School Board jointly have made to secure the co-ordination of all educational efforts within their borders, and so avoid that over-lapping which is such a prolific source of loss and disappointment in many other districts, this centre of the great cotton industry may well serve as an example of a community where the first object of public men is to secure educational efficiency and not to assist the glorification of a particular board or committee.

This success is largely to be attributed to the recognition of the fact that any successful system of technical instruction must be adequately based upon a graduated supply of elementary and secondary education. It is too often imagined that technical education is independent of the work of the public elementary and the grammar schools. But in Manchester it has been for years borne in mind that it is only those youths who have received a thorough preliminary education who reap any advantage from the lectures and laboratory work of the technical school, be it never so perfectly equipped and staffed. The student of education consequently finds, when he endeavours to account for the satisfactory system of technical instruction in Manchester, that, in addition to the ordinary public elementary schools, supplying besides the three R's an elementary introduction to the principles of physics and chemistry, the School Board have provided four higher grade schools, all of them furnished with a "School of Science," and, as readers of NATURE know, the curriculum of schools of this type is eminently suitable as an introductory course for boys and girls who will later proceed to the technical school.

Adequate provision is also made for the children of a higher social status. Manchester is well provided with secondary schools. Its Grammar School and its High School for Girls both deservedly occupy high places among the public schools of the country. Manchester Grammar School, moreover, appears to have been one of the first to teach practical chemistry, for it possessed a small laboratory as long ago as 1868.

There is, too, every facility offered to bright children of the elementary schools to pass forward either to the Higher Grade School or to the Grammar School—this desirable end being secured by a sensible scheme of scholarships. By the same means a vital connection is assured, by way of the secondary schools, between the elementary schools and the Municipal Technical School and the University College.

Nor are the educational needs of youths who have begun the serious business of life neglected. All the schools, to the work of which brief reference has been made, are intended for young people who have as yet entered neither trade nor profession. But in all manufacturing districts the great mass of the workers have to complete their education by well-sustained efforts in evening classes of one kind or another. The authorities in Manchester are fully alive to this fact, and a wonderfully complete system of evening classes has grown up, in which it is interesting to note that the School Board and the Technical Instruction Committee can work together without friction and with the best results. Two sets of these classes are in vogue. First, there are the classes with which the School Board are more directly concerned—the evening continuation schools in which youngsters from twelve to sixteen years of age, who have left the public elementary school for the shop, the warehouse, or the factory, are either preparing themselves for the more advanced classes of the technical school, or are perfecting and continuing the work they did at school with a view to making themselves of greater value to their employers. Secondly, there are the evening classes of the technical school, intended for young men and women of sixteen and upwards, of which it is difficult to give an adequate idea in a few sentences. To really appreciate what is being done in such classes every winter's evening in large manufacturing districts, it is necessary to visit the schools where they are held. The determined efforts the young men and women, who, be it remembered, have generally spent a laborious day earning their daily bread, will make in order to become acquainted with the principles of science on which their work depends, or to become familiar with the canons of art they hope to apply in designing, is well calculated to inspire the hope that this country will some day take its former position in the industrial contest among the nations.

The students of the Day Technical School and Day School of Art are composed chiefly of the sons of middle class parents. In the majority of cases they do not enter seriously into the work of manufacture and distribution until after completing their studies. It is gratifying to be able to report that there are some exceptions to this rule. Some enterprising employers have made arrangements for sending certain of their employees to the technical school during the day—the employers themselves bearing the expense thereby incurred. It is much to be desired that this far-seeing policy may be more generally adopted. And there are also the scholarship-holders from the higher grade schools. Such is, in skeleton form, the system of technical education which has been gradually evolved in Manchester. The accompanying pictorial representation gives a bird's eye view of the whole arrangement. The illustration, which was prepared by Mr. J. H. Reynolds, the Director of the Manchester Technical and Art Schools, was awarded a gold medal by the International Jury of the Paris Exhibition.

Another cause of the high state of development of education in Manchester is the broad view which the Technical Instruction Committee have taken of their duties. On at least two separate occasions they have arranged for their Director, with certain members of the committee, to visit foreign countries to study other systems of technical instruction, and on another occasion they have sent him alone to visit the United States. In this way these Manchester authorities have become practically acquainted with German and American ideas of education. They have not endeavoured to follow slavishly such methods in their entirety, but have not hesitated to import notions they considered suitable for the peculiar needs of their own district.

The same committee have also taken a large part in the formation of public opinion in matters educational in Lancashire. At their instigation several conferences have been held of representatives of the numerous county boroughs in their immediate neighbourhood. Resolutions have been adopted and widely circulated urging the need of legislation to ensure that secondary (including technical) education shall be placed under the control of municipal councils, though the desirability of co-opting upon the Educational Committee an effective minority of persons of special experience in all grades of instruction, as well as of encouraging the joint action between the authorities of county boroughs and that of the administrative county have been recognised. But, if they would consider this question more from the national point of view, this enterprising local authority for education might come to a different conclusion. What is the state of affairs in south-east Lancashire? For the sake of example let Manchester be taken as a centre, and consider chiefly the technical education of the district. In this central city there will shortly be, in full working order, a technical school, erected and equipped at a cost of upwards of a quarter of a million, and really provided with accommodation enough for all the advanced technical students which the whole area under consideration could provide. Yet, within easy walking distance, there is the Salford Royal Technical Institute, also admirably organised and generously staffed, and this simply because Salford happens to be a separate borough. The other boroughs of this same area are, moreover, very close together. Stockport, with its own technical school, is within about five miles, and has a splendid train service connecting it with Manchester. Bury, Bolton, Oldham, Rochdale, and other boroughs are sufficiently near for their advanced students to be drafted to Manchester for instruction—the railway fares could easily be provided by means of scholarships. It would certainly seem as though, in the best interests of technical education, an area much larger than that of a county borough is desirable. With boroughs so near as they are in south-east Lancashire there is bound to be duplication and re-duplication of buildings and appliances. To have a school, like the new technical school at Manchester will be, engaged in elementary work, which could be done equally well at much less cost elsewhere, is to lose a grand opportunity of providing one centre at least for advanced technical instruction, of which the country stands in growing need. Experience shows, too, that the same staff cannot successfully undertake to teach crowds of elementary pupils and

also really be of assistance to the comparatively few picked students who will well repay any opportunities placed in their path for advanced study and subsequent research in applied science.

That there is no difficulty in getting students to travel, as has been suggested, is borne out by an appendix to the last report of the Manchester Committee for Technical Instruction. It is there set forth that last year there were, among the 4313 students of the technical school, no fewer than 2266 students from out-districts, of whom 18 came from Bolton, 25 from Bury, 44 from Oldham and Hollinwood, 16 from Rochdale, 348 from Salford, and 43 from Stockport, to name only a few towns from a long list in the report before us.

It is not recognised sufficiently that the technical education this country stands in need of is not elementary instruction in pure science. It has been demonstrated again and again in these columns that such teaching is really a part of every reasonable system of secondary education. When this is fully understood, the large classes in elementary science subjects will disappear from our technical schools. In their place we shall have students at work who, before entering the technical school, have become familiar with the broad principles of physical and chemical science, and who are now in a position to turn their attention to technical science—the application of pure science to the industry with which the student is connected.

Such a policy as has been indicated would make another desirable development possible. A specialisation of function on the part of schools in different towns could then be encouraged where necessary. Given a thoroughly representative authority for a sufficiently large area, and the apparent necessity of a class in every conceivable subject for each borough disappears. Each important technical school will be able to bend its efforts to solving the question of the proper form of technical instruction for one particular industry, or part of an industry. And Manchester, with the large number of great towns in its immediate neighbourhood, is an ideal district in which to begin some such sensible and economical supply of technical education. By all means let us have a generous supply of elementary evening classes in every town, but do let it be borne in mind that this work should only be regarded as preparatory. The serious need is for more centres where advanced students are looked after.

In conclusion, another instance of the enterprise of the Manchester Committee must be mentioned. At the instigation of their Director they have secured for exhibition in Manchester the fine educational collection which the American Government sent to the Paris International Exhibition. Invitations to teachers and others interested in education to come and examine this unique collection of objects are being sent far and wide. It cannot but have a good effect to show English educationists some of the ways in which America is in advance of us in this matter of training intelligent workmen.

A. T. SIMMONS.

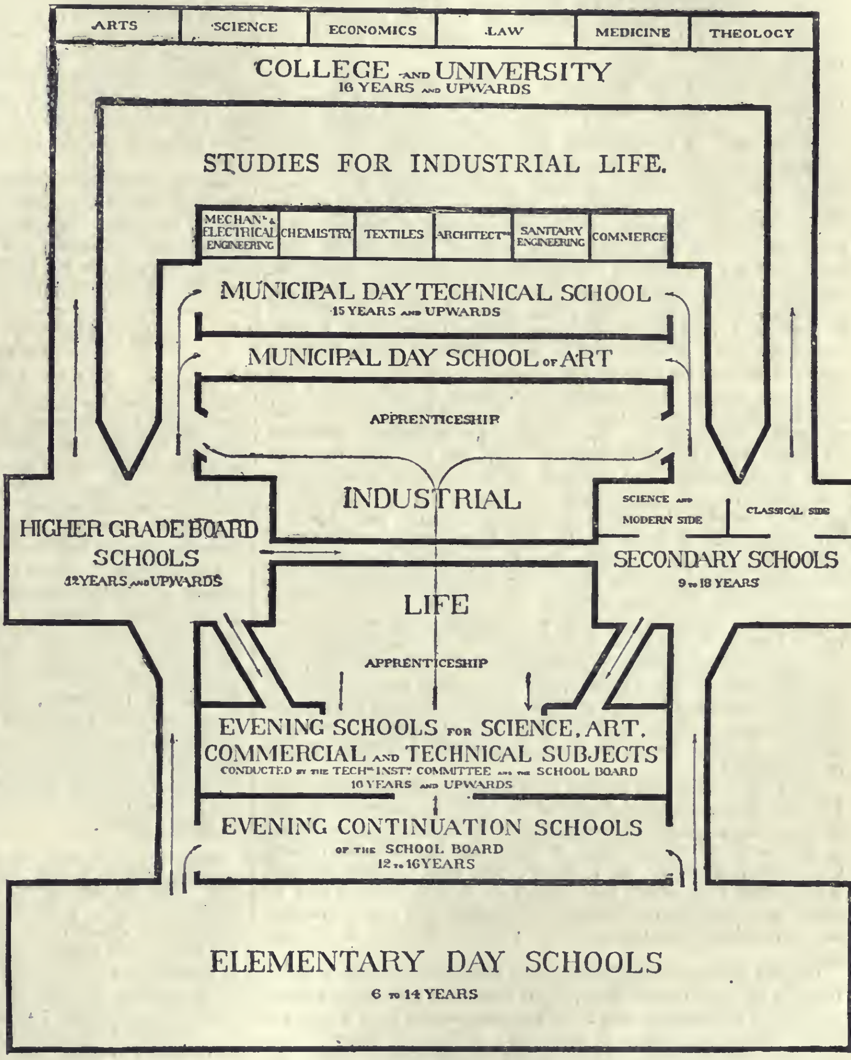


DIAGRAM ILLUSTRATING THE CORRELATION OF EDUCATION IN THE CITY OF MANCHESTER.

METHODS OF FORMATION OF HAIL.[1]

THERE are many reasons for believing that hailstones are formed in the free atmosphere by some one of several different processes, each of which may be in accord with the laws of thermodynamics:—

(1) An ascending mass of air may be so dry that it does not cool to the dew-point until far below the freezing temperature, in which case the deposit is either fine spiculæ of ice or aggregations of these into small snowflakes.

(2) If the dew-point is a little higher than the preceding, the cloudy condensation may occur at temperatures just above the freezing point, and the watery particles may be carried up a little higher and frozen into what is called frozen fog. These same particles, when driven by the wind against an object, accumulate on it as frostwork.

(3) When a rising mass of air forms a large cumulus cloud at a low level, having a rapidly ascending current in its interior,

[1] Abridged from a contribution by Prof. Cleveland Abbe to the U.S. *Monthly Weather Review*.

the latter, by its buoyancy, will rise much higher than if there were no cumulus cloud; it may pass upward into the so-called hail region, where water drops and ice particles may coexist, and still higher up into the region where only ice and snow can exist.

(4) Raindrops falling from relatively warm clouds through a very cold stratum of air below may be frozen into sleet before they reach the ground.

To these four elementary methods of forming atmospheric ice we have to add the mechanical processes by which the small particles accumulate as large hailstones. Undoubtedly much light was thrown upon this subject by the notes made by observers on Pikes Peak during the early years of the occupation of that station.

In the thermodynamic studies of Hertz and von Bezold is employed the expression "the hail stage," viz. that stage in which the temperature of 32° prevails in an ascending mass of moist air. It is supposed that the ascending air, having already cooled to the dew-point, is carrying up with it a quantity of water, either in small cloud particles or in large raindrops. When these have ascended to the level where the rising moist air is cooled to the temperature of freezing, they continue to give up to the air a little of their specific heat until they are themselves frozen into hail or sleet. There is, therefore, a thin layer of air in which this process of freezing is going on and where the rising mass of mixed air and rain is kept at a uniform temperature until all the water is converted into ice. This is spoken of by Hertz as the hail stage; below it is the rain stage and above it is the snow stage. In this latter region the ascending air, being already cooled below the freezing point, can deposit its moisture only as snow or small crystals of ice. Now the actual hailstones observed on Pikes Peak are so frequently composed of snow that has been partly melted and refrozen, or mixed with water drops and refrozen, that we cannot suppose them to have been wholly formed within the thin layer known as the Hertzian hail stage. It is more likely that they are formed partly within that and partly within the Hertzian snow stage. The memoir of Hertz assumes throughout that the changes of temperature within the ascending air are strictly adiabatic. This requires that the ascent be so slow that the drops of water carried upward maintain the same temperature as the surrounding air. But these two conditions are almost physically incompatible; it is probable that neither of them are ever realised in nature. Among other combinations that are possible and may help to explain the great variety of forms of hailstones that are caught upon the summit of Pikes Peak, we may suggest the following as the most common:—

(1) Frozen raindrops carried very rapidly upward through the Hertzian hail stage may continue on into the snow stage and grow by the accretion of snowflakes until they are finally dropped to the earth, in which latter process they continue increasing their snowy covering. If, however, they pass through the hail stage before they reach the ground in their fall, they will be found to consist of an icy nucleus surrounded by a snowy envelope and covered over all by a layer of a frozen mixture of ice and snow.

(2) Air that has ascended into the snowy stage without going through the rain or hail stage, or, at least, to a very slight extent, because of its dryness, may form large snowballs high above the Peak before beginning to fall. As such balls descend very rapidly, the interior retains a low temperature, while the exterior is slightly warmed and melted by the action of the warmer air that the snowballs find near the ground. The result is large hailstones, consisting each of a thin layer or crust of ice and a snowy mass within.

(3) In the formation of snow and hail in the midst of ascending currents of air, we must expect to notice the same phenomenon as in the formation of rain, viz. after the first condensations have taken place upon dust and foreign substances the rising mass of cloud represents dustless air in the presence of water particles, but cooled by expansion to such an extent that the air between the drops, or the ice spiculæ, is in a state of supersaturation. When this condition has become too intense, large quantities of aqueous vapour suddenly condense, rushing together into large drops of rain or large masses of snow, and carrying with them all the finer particles within their respective spheres. At the very low temperatures at which this occurs, water will hold considerable air in solution, and additional air is also included at the centre of the snowball among the particles of snow and ice. Such large snowballs are heavy enough to descend rapidly from the snowy stage, through the rain and hail stages to the ground, and in so doing they become saturated with water which recrystallises forming solid hailstones, but at the centre of the mass they still hold, confined, the air originally included in the snowball, and this is compressed under several atmospheres, as was shown in 1869, by P. Reinsch (see *Pogg. Ann.*, 1871, or *Phil. Mag.*, 1871, vol. xlii. p. 79), who observed that when such hailstones are melted under water the little bubble of air at the centre is seen to suddenly escape and expand sufficiently to demonstrate the existence of a pressure of fifty atmospheres under which it was confined. In this formation of snowballs and the resulting hail from supersaturated air within the snow stage there is an electric disturbance entirely analogous to that which takes place when great drops of rain are formed within the rain stage. In both cases violent thunder and lightning are observed just before the fall of the hail or the rain.

These and other hypotheses that might be framed relative to the methods of formation of the various kinds of hailstones must, however, only be regarded as suggestions intended to stimulate experimental and theoretical research in this direction. One cannot doubt but that the history of the formation of hail is written in its structure if we could but interpret it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. W. J. Sollas has been elected to a fellowship at University College. This fellowship, however, is not to be regarded as attached to the professorship of geology; the election concerns the present professor only, the College being under no obligation to his successor.

Prof. Townsend, the new Wykeham professor of physics, has come into residence, but the space intended for his laboratory will not be available until the Radcliffe Library has been transferred to its new building.

CAMBRIDGE.—The Clerk-Maxwell studentship in physics, tenable at the Cavendish Laboratory, has been awarded to Mr. H. A. Wilson, Trinity. Mr. P. V. Bevan has been appointed assistant demonstrator in physics, in succession to Prof. Townsend. Mr. J. C. M. Garnett has gained the Sheepshanks astronomical exhibition at Trinity College. Mr. L. Whibley, Fellow of Pembroke, has been appointed assistant to the secretary of the University Press Syndicate. Mr. Yule Oldham, Reader in geography, is lecturing this term on the hydrosphere, and on the geography of Central Europe. A grant of 50*l.* for the current year has been made to the Department of Pathology, towards the course of instruction in bacteriology for the diploma in public health.

THE Report of the U.S. Commission of Education for the year 1898–99 has been received. It is a volume of thirteen hundred pages, containing papers and statistics on many branches of educational activity in various countries. Among the subjects of papers of interest in connection with instruction in sciences are school gardens, by Herr E. Gang; the teaching of geography, by Dr. A. J. Herbertson and others; manual training in Germany; minor mental abnormalities in children as occasioned by certain erroneous school methods; and an annotated chronological list of American text-books on arithmetic, prepared by Drs. J. M. Greenwood and A. Martin.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, January.—Heavy rainfall of December 30, 1900. The official weather charts showed that the centre of a barometric depression lay over the middle of Ireland in the morning of that day, and that it moved southeastwards, passing Bristol in the early evening, and reaching the English Channel on the morning of the 31st. This storm was remarkable for the heavy rains which fell in the valley of the Severn and its tributaries. Falls exceeding two inches in 24 hours occurred over a broad diagonal belt from the mouth of the Severn to the mouth of the Humber, while amounts exceeding three inches occurred in a narrow strip running for about 85 miles in a northeast direction from near Bristol and Chepstow, covering an area of nearly 1000 miles.—The mild December. The mean temperature for the month in the north-

west of London was 6°·2 above the average for 40 years, and the mean maximum and mean minimum exceeded the average by about the same amount. The month ranks with the mildest of the last half century, but was equalled by December 1898, and exceeded by December 1868. The number of days (19) on which the temperature exceeded 50° is unprecedented in this series of observations, for there were only 18 such days in 1868 and 17 in 1898. The present number of this popular magazine completes the 35th volume. The magazine, while retaining its special interest in rainfall, will in future deal more fully with all branches of meteorological science than it has done in the past.

Bollettino della Società Sismologica Italiana, vol. vi. No. 5.—Seismic Greece, by F. de Montessus de Ballore. A study of the geographical distribution of earthquakes in Greece.—On the velocity of the earth-waves of the Roumanian earthquake of September 10, 1893, by C. Davison (in English). Good observations of the time were obtained at Bucharest and Oxford, the latter by Prof. Boys in his experiment on the Newtonian constant of gravitation. They give a mean surface-velocity of 3·98 km. per second.—Three-component seismometrograph for strong earthquakes, by G. Agamennone. A first sketch of a proposed instrument.—Seismometrograph with continuous-velocity registration, by A. Cancani.—Notices of earthquakes recorded in Italy (August 4 to 24, 1899), by A. Cancani, the most important being distant earthquakes on August 17 and 24.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, January 17.—Prof. Thorpe, President, in the chair.—The following papers were read:—The preparation of iodic acid, by A. Scott and W. Arbuckle. The authors prepare iodic acid by heating powdered iodine with nitric acid in a glass flask fitted with a ground-in reflux condenser and a tube by means of which oxygen is passed through the boiling liquid.—Note on isomeric change and meta-substitution in benzenoid amines, by A. Lapworth. The author explains the action of fuming sulphuric acid on dimethylaniline by means of an extension of his previously published views on the occurrence of isomeric change.—The preparation of esters from other esters of the same acid, by T. S. Patterson and C. Dickinson. It is shown that ethyl tartrate can be converted into methyl tartrate by the action of methyl alcohol and hydrogen chloride, and that methyl tartrate can be converted into ethyl tartrate by an analogous process.—Tecomin, a colouring matter derived from *Bignonia tecoma*, by T. H. Lee. The wood of *Bignonia tecoma* yields a yellow crystalline colouring matter, and is used locally as a dye for cotton and as a stain for wood.—A new method for the measurement of ionic velocities in aqueous solution, by B. D. Steele. The method consists in enclosing the liquid to be examined between two partitions of gelatine which contains the indicator ion in solution. On the passage of the current the cation of the solution is followed by the cation of the indicator, and the anion of the solution by the corresponding anion of the indicator. It is necessary in all cases that these indicator ions should move more slowly than the ion to be measured; the motion is followed by means of a cathetometer.—Metal-ammonia compounds in aqueous solution, Part ii. The absorptive powers of dilute solutions of salts of the alkali metals, by H. M. Dawson and J. McCrae.—The amide, anilide and toluidides (ortho- and para-) of glyceric acid, by P. F. Frankland, F. M. Wharton and H. Aston.

MANCHESTER.

Literary and Philosophical Society, January 22.—Prof. Horace Lamb, F.R.S., President, in the chair.—The President referred to the loss sustained by the Society through the death of Prof. Ch. Hermite, one of its honorary members.—Mr. Francis Jones showed the mode of detecting small quantities of arsenic by Marsh's, Reinsch's and Gutzeit's methods. He also showed the results obtained by the action of light on the hydrides of arsenic and antimony in contact with sulphur, constituting a further test of the presence of these metals. The result obtained from a glass of arsenical beer by Marsh's test was also exhibited, together with a sample of invert-sugar containing arsenic.—Mr. R. L. Taylor remarked upon the occurrence of arsenic in certain green tapers, of which he showed two varieties obtained from half-a-dozen samples purchased in the neighbourhood of Manchester, and demonstrated the presence of a marked quantity of arsenic in a short piece cut off from one of these tapers.—Dr. C. H. Lees mentioned a very compact formula for the circumference of an ellipse due to Mr. Thomas Muir, which is readily calculated with the aid of Barlow's tables. The accuracy of the approximation is very marked.

EDINBURGH.

Royal Society, January 7.—Prof. Copeland in the chair.—Mr. W. S. Bruce, in a paper on exploration in Spitsbergen and soundings in seas adjacent, gave an account of the work he had undertaken in conjunction with the Prince of Monaco in the yacht *Princess Alice*, and with Mr. Andrew Coats, of Paisley, in the yacht *Blencartha* (now *Pandora*). One main object of the *Blencartha* expedition of 1898 was the determination of salinities and temperatures in the Barentz Sea, an important result being the delineation of the isotherms in the successive summer months. In the expedition of 1899, the Prince of Monaco's chief aim was to survey the littoral regions to the north and north-west of Spitsbergen. The most detailed work was done in Red Bay, which they found to be very inaccurately described in the Admiralty map, and in which they had taken over 2000 soundings and 2700 angles. Many new peaks and glaciers were discovered and named, one to the south of the bay being named Peak Ben Nevis. The greatest depths in the bay were much greater than the depths in the open sea beyond, a fact which seemed to prove the glacier origin of the bay. The paper was fully illustrated by a number of lantern slides, which brought out clearly much of the geological and zoological character of Spitsbergen and Novaya Zembla.

PARIS.

Academy of Sciences, January 21.—M. Fouqué in the chair.—Notice on M. Ch. Hermite, by M. C. Jordan.—Notice on M. Adolph Chatin, by M. Gaston Bonnier.—Influence of the substitution of alcohol for sugar in food, in isodynamic quantity, on the value of the muscular work accomplished by the subject, by M. A. Chauveau. The experimental results obtained during a period of 389 days show that the partial substitution of alcohol for sugar in the food ration in a subject doing work has an unfavourable effect from all points of view, there being a diminution in the absolute value of the muscular work, and an increase in the food used up with respect to the work accomplished.—On the influence of climate upon the evolution of experimental pleuro-pulmonary tuberculosis, by MM. Lannelongue, Achard and Gaillard. Three hundred guinea-pigs were inoculated with human tuberculosis, and then submitted to varying climatic conditions, some remaining in the laboratory at Paris, others being taken to the sea, open country, mountains, &c. The advantage appeared to be with those remaining in the laboratory. Although in each lot all the animals were inoculated with the same virus on the same day, great differences occurred in the development of tuberculosis.—On the supplementary condition in hydrodynamics, by M. P. Duhem.—M. Mascart announced to the Academy the death of M. Gramme.—On the telescopic planets, by M. R. du Ligondès. An analysis of the distribution in space of the telescopic planets shows that the assumption that they represent the *débris* of a nearly flat circular ring does not explain all the facts. The more probable hypothesis would appear to be the generation of the planets by successive agglomerations of matter circulating in the interior of the solar nebula.—On the generalisation of a theorem of M. Picard, by M. S. Kantor.—On a theorem in the calculus of probabilities, by M. A. Liapounoff.—On the liquefaction of gaseous mixtures. Variation of the concentrations of the two co-existent liquid and vapour phases along the isotherms, by M. F. Caubet. It is shown that any mixture of CO_2 and SO_2 which, at 66°·3 and under a pressure of 57·6 atmospheres, can give two co-existing phases, will give a liquid phase of concentration 0·70926, and a vapour phase of concentration 0·33238.—On some properties of sodium peroxide, by M. de Forcrand. The author points out that the method of preparation of hydrated sodium peroxide, given by M. Jaubert in a recent number of the *Comptes rendus*, is identical with that published by Prof. Vernon Harcourt forty years ago.—On the combinations of ammonia with aluminium chloride, by M. E. Baud. The author's results differ from those previously obtained by Persoz and Rose. At least four stable compounds exist, $Al_2Cl_6.2NH_3$, $Al_2Cl_6.10NH_3$, $Al_2Cl_6.12NH_3$, and $Al_2Cl_6.18NH_3$. The first of these distils without decomposition at 450° C.—On the isolation of yttria, ytterbium, and the new erbium, by MM. G. and E.

Urbain. The crude earths from gadolinite are converted into ethyl sulphates. After ten crystallisations the mother liquors contain only the three elements yttrium, erbium and ytterbium, with perhaps a trace of thorium. These were further separated by the fractional decomposition of the nitrates by heat, which, in the absence of earths of the gadolinium group, gives a very satisfactory separation.—On an arsenide and chloro-arsenide of tungsten, by M. Ed. Defacqz. The interaction between hydrogen arsenide and tungsten hexachloride is analogous to that with the corresponding phosphorus compound, two compounds of the composition WAs_2 and W_2AsCl_6 being isolated.—On nitrofurfurane, by M. R. Marquis. By allowing anhydrous nitric acid and furfurane in acetic anhydride solution to react at $-5°$ C., a nitrofurfurane can be obtained. The exact position of the nitro-group is not yet determined.—The absorption spectra of the indophenols, by M. Paul Lemoult.—On some new organometallic compounds of mercury, by MM. Auguste Lumière, Louis Lumière, and Chevrotier. When alkali phenol disulphonates react with mercuric oxide, compounds are formed of great solubility, and presenting some peculiar reactions, not being precipitated by soda, hydrochloric acid, or ammonium sulphide. Their taste is purely saline, and not metallic as is usual with mercury salts. The solutions, however, possess great antiseptic power.—On the mechanism of diastatic reactions, by M. M. Hanriot. By studies on the ferment lipase it is shown that the ferment, when attenuated by a chemical action, may regain its original activity, and also that the action of lipase upon acids and ethers appears to be a chemical combination governed by the ordinary laws of dissociation.—On the plurality of the chlorophyllines and on the metachlorophyllines, by M. M. Tsvett.—On a pseudo-agaric acid, by MM. Adrian and Trillat. The body extracted from agaric by alcohol does not appear to be a true acid, and when pure is without special physiological properties.—Transformation of creatine into creatinine by a soluble dehydrating ferment in the organism, by M. E. Gérard.—Modes of formation and preparation of propylbenzene, by M. F. Bodroux. Normal propylbenzene is formed along with other products by the interaction of benzene, trimethylene bromide and aluminium chloride.—Filtration of air by the soil, by M. Auguste Gérardin.—On the *rôle* of the chlorophyllian function in the evolution of terpenic compounds, by M. Eug. Charabot. Any influences which increase the vigour of the chlorophyll function in plants also appears to favour the production of the ethers of terpene alcohols.—On the chemical composition of the coffee from Grande Comore, by M. Gabriel Bertrand.—Action of mucus upon the organism, by M.M. Charrin and Moussu. Fresh mucus possesses poisonous properties when injected into the blood.—Radiopelvigraphy and radiopelvimetry at long range, by M. Henri Varnier.—The sponges of the Belgian Antarctic expedition, and the bipolarity of the fauna, by M. E. Topsent.—Origin of the pigment in Tunicates. The transmission of the maternal pigment to the embryo, by M. Antoine Pizon.—A new theory of chromatic adaptation, by M. Georges Bohn.—Researches on the structure of some of the lower fungi, by M. Guilliermond.—Apparent symmetry in crystals, by M. Fréd. Wallerant.—On the origin of the gold in Madagascar, by M. A. Lacroix.—On the age of the eruptive rocks of Cape Aggio, by M. Leon Bertrand.—The dômes of Saint Cyprien (Dordogne), Sauveterre and Fumel (Lot-et-Garonne), by M. Ph. Glangeaud.

DIARY OF SOCIETIES.

MONDAY, FEBRUARY 4.

VICTORIA INSTITUTE, at 4.30.—Ancient Script in Australia: E. J. Statham.

TUESDAY, FEBRUARY 5.

ROYAL INSTITUTION, at 3.—Practical Mechanics: Prof. J. A. Ewing.

ZOOLOGICAL SOCIETY, at 8.30.—On the Mammals of the Balearic Islands: Oldfield Thomas.—On the Structure of the Horny Excrescence known as the "Bonnet" of the Southern Right Whale (*Balaena australis*): Dr. W. G. Ridewood.—A List of the Batrachians and Reptiles obtained by Dr. Donaldson Smith in Somaliland in 1899: G. A. Boulenger, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Present Condition and Prospects of the Panama Canal Works: J. T. Ford.

WEDNESDAY, FEBRUARY 6.

ROYAL INSTITUTION, at 3.—Government and People of China: Prof. R. N. Douglas.

GEOLOGICAL SOCIETY, at 8.—On the Origin of the Dunmail Raise (Lake District): D. Oldham.—On the Structure and Affinities of the Rhætic Plant *Naiadita*: Miss Igerna B. J. Sollas.

THURSDAY, FEBRUARY 7.

ROYAL SOCIETY, at 4.30.—*Probable papers*: The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers: Prof. Dewar, F.R.S.—On the Brightness of the Corona of January 22, 1898. Preliminary Note: Prof. H. H. Turner, F.R.S.—Preliminary Determination of the Wave Lengths of the Hydrogen Lines, derived from Photographs taken at Ovar at the Eclipse of the Sun, 1900, May 28: F. W. Dyson.—Investigations on the Abnormal Outgrowths or Intumescences on *Hibiscus vitifolius*, Linn.: a Study in Experimental Plant Pathology: Miss E. Dale.—On the Proteid Reaction of Adamkiewicz, with Contributions to the Chemistry of Glyoxylic Acid: F. G. Hopkins and S. W. Cole.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Action of Hydrogen Bromide on Carbohydrates: H. J. H. Fenton and Mildred Gostling.—Note on a Method of comparing the Affinity-Values of Acids: H. J. H. Fenton and H. O. Jones.—Organic Derivatives of Phosphoryl Chloride, and the Space Configuration of the Valencies of Phosphorus: R. M. Caven.—(1) Synthetical Work with Sodamide Derivatives; (2) Note on Two Molecular Compounds of Acetamide; (3) Diacetamide, a New Method of Preparation: Dr. A. W. Titherley.

RÖNTGEN SOCIETY, at 8.—Experiences of X-Ray Work during the Siege of Ladysmith; Lieut. F. Bruce.

FRIDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 9.—History and Progress of Aërial Locomotion: Prof. G. H. Bryan, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual General Meeting.

GEOLOGISTS' ASSOCIATION, at 8.—Annual General Meeting.—Twelve Years of London Geology: The President, W. Whitaker, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Mr. Wimperis' paper on Cycle Resistance will be submitted for discussion.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Power-Gas and Large Gas-Engines for Central Stations: H. A. Humphrey.

ANATOMICAL SOCIETY, at 4.30.—The Origin of the Vertebrate Ear and Eighth Pair of Cranial Nerves: W. H. Gaskell, F.R.S.—A Critical Review of Recent Literature on Fossil Anthropoids: W. L. H. Duckworth.

CONTENTS.

THURSDAY, FEBRUARY 7, 1901.

A NEO-DARWINIAN ON EVOLUTION.

Problems of Evolution. By F. W. Headley. Pp. xvi+373. (London: Duckworth and Co., 1900.)

MUCH of the work that has lately appeared on the subject of organic evolution has been characterised, if not by a misapprehension of the main points at issue, at any rate by a want of due proportion in the treatment of data, and by a tendency to build an elaborate superstructure on a very slender foundation of fact. This applies less to the work of English authors than to those of other countries. It is satisfactory to find that English men of science, who have always taken a leading part in the promotion of sound and rational views on the methods of evolution, are still distinguished by the thoroughness and good sense which they bring to bear on the discussion of evolutionary problems.

Mr. Headley's book is on the whole a favourable example of this kind of literature. It is true that his statements of fact are not always free from error, nor are his arguments on all points convincing; he shows, nevertheless, a just appreciation of the difficulties of the subject and a wide acquaintance with the various attempts that have been made towards their solution, while his own suggestions have been well considered, and are often of distinct value. His standpoint is more thoroughly Darwinian than that of many other recent writers, and in him the principle of natural selection as the most important factor in evolution finds a powerful and skilful advocate. He is an uncompromising opponent of Lamarckism, and one of the most satisfactory sections of the book is that in which he shows how completely the Lamarckian principle fails to account for those very phenomena which have been most confidently appealed to in its support. This, however, does not preclude him from recognising the importance of the suggestion made independently by Profs. Mark Baldwin and Lloyd Morgan, viz., that the selection value imparted to a congenital variation by exercise may enable such variation to become the starting-point for other variations in the same direction (Darwin's "Continuity of Variation"). Not only does he adopt the principle in the form here stated, but he goes on to show that parental care and the gregarious habit may act in a similar way by promoting the survival of certain characters which can be increased by practice, and so giving an opportunity for their enhancement, by further variation, in successive generations. But he rightly points out that this cannot properly be claimed by Lamarckians as a concession to their views; those who would so claim it must have, as he says, "a singular power of mistaking an utter rout for a compromise." For, as Prof. Lloyd Morgan makes clear, there is here "no transmission of modifications due to individual plasticity"; and what really emerges is that natural selection is capable, without such transmission, of doing all that was exclusively claimed on behalf of Lamarckism.

On the defensive side, Mr. Headley makes a forcible use of the phenomena of adaptation. He has little to bring forward that is actually new on this head, but his statement of the case is a clear and cogent one. The principle of recognition marks is acknowledged by him as supplying the key to many instances of apparently useless characters, and this line of argument might profitably have been expanded. He is on strong ground when asserting the importance of slight points of difference.

"Two races are brave beyond dispute, but one will stand a little longer under fire than the other, and it is this little that makes all the difference in the struggle. Two young men are about on a par, and seem likely to run neck and neck in the race of life, but an almost imperceptible superiority in one seems to act with cumulative effect, and in twenty years, say, he is miles ahead."

The latter illustration will appeal to most readers with experience of life.

The author's treatment of the important subject of variation is interesting and suggestive. True to his anti-Lamarckian principles, he denies any direct influence of the environment on the origin of variations properly so-called: "An external condition can do nothing but bring to light some quality" already latent. To explain the variations among offspring we must fall back on the doctrine of the continuity of the germ-plasm coupled with the specialising effect of cell-division.

"When fission takes place, inequality must result. . . . There is a thorough shuffling of the cards before they are cut."

This view is to some extent akin to Weismann's earlier position as to the import of reducing divisions and amphimixis. But the author goes further than Weismann. Not only have the reducing divisions of the germ-cells in the metazoa the value of an incipient specialisation, but the simple fissions of the protozoa have precisely the same significance. Over-specialisation, such as would in many cases result from a process of fission indefinitely continued, is a cause of failure and death. This in the bulk of the protozoa, at all events, is counteracted by periodical conjugation, which tends to restore to each cell some elements which it had lost, or was in process of losing, by repeated fission. Amphimixis in the metazoa has a similar *rôle*. Hence both fission and conjugation, or amphimixis, are a cause of variation, though the latter, while increasing the possibilities of deviation, tends to prevent it from taking a harmful direction. An obvious criticism on this view is that two imperfect organisms do not necessarily make a perfect one. The speculation, nevertheless, is ingenious and interesting, even though it may fail to convince.

In a further discussion of that perfection of adaptation which almost appears to call for a "directive force" presiding over variation, he takes occasion to give an account of Prof. Weldon's application of the law of chance. The argument is fairly stated, but in his comments upon it Mr. Headley seems disposed to blame Prof. Weldon's results for not clearing up points with which they were never intended to deal. His criticism is thus somewhat beside the mark, for, as he himself admits, Prof. Weldon's aim was chiefly to demonstrate the high probability of advantageous variations affecting a large number of individuals at the same time, in this way affording abundant material for selection. The question why variation should take one direction more than another belongs to

a distinct line of inquiry. In framing his own answer to the question, the author lays stress on the controlling power of heredity, on Darwin's principle of "continuity of variation," or, as he prefers to call it, "sequence of variation," and also on the fact that the variations of the organic environment of a species—the several other species, that is to say, with which it has to keep *en rapport*—being subject to similar limitations with its own, are not likely to set it an impossible task in the way of providing fresh adaptations. Moreover, there are usually periods in the history of a species when it has, as it were, a choice of environments, so that the possibilities of adaptation open to it are enlarged. This latter position might well have been illustrated by the striking case of certain mimetic butterflies; amongst which it is often found that species closely allied to one another, and sometimes even the two sexes of the same species, have been drawn apart, so to speak, into separate protected colour-groups; while still other species of the same affinities occupy intermediate positions, ready, as it were, to throw in their lot with this or that colour-combination, according to their needs. The upshot of the author's contention as to variation and adaptation is, that while the range of possible variation is not indefinite, but necessarily limited, the limitation is in no sense due to the direct action of the environment; still it is this very limitation that renders adaptation possible, by ensuring a supply of such material as is capable of being moulded by the selective action of the existing external conditions. Variation that took place merely at random, were it conceivable, would almost inevitably consist of all misses and no hits.

In the second and concluding part of the book, Mr. Headley deals with the application of evolutionary doctrine to the problems of human development. His treatment of this part of the subject, as of the other, shows freshness, vigour and ability; but he could here hardly avoid raising points of a highly controversial character, and most of his conclusions are likely to be sharply assailed. Adopting in many respects the point of view of Mr. Benjamin Kidd, he discusses at length the origin and influence of the moral sense, and the various conditions that with advancing civilisation tend to defeat or delay the operation of natural selection. The antagonism between altruism and the "cosmic process," which was adumbrated by Huxley in his memorable Romanes lecture, receives a careful and extended treatment; and the author states his own conclusion somewhat as follows:—The development of human intelligence has in many ways checked the wholesome operation of natural laws. Being capable of exercise in anti-social directions, it has in times past threatened the well-being if not the very existence of the race. From this fate humanity has so far been preserved by the practice of altruism under the sanctions of religion and morality. Supposing this first peril to have been successfully met, there remains the further danger of physical degeneration, which may presently become imminent, and the proper treatment of which is among the most important problems that await us. In spite of his indictment of human reason, Mr. Headley is no pessimist. So far from having lost confidence in the future of the race, he looks boldly to the old sanctions, under higher and more enlightened forms of application, to save the human species from physical, as they already have from social disintegration. It is obvious that the working out of this idea, which indeed is not attempted by the author himself in any detail, involves considerations which are unsuitable for discussion in a notice like the present. Suffice it to say that Mr. Headley does not write at random; and that his views challenge attention, whether sympathetic or otherwise.

Notwithstanding an occasional abruptness and jerkiness of style, the author writes well and expresses his views with clearness. More care might with advantage have been bestowed on the proofs; misprints are not uncommon, the punctuation frequently leaves much to be desired, and there is a curious lack of uniformity in the use of scientific names. Some questionable palæontology will be found on p. 105, and some equally doubtful pathology on pp. 246, 247. An inaccurate use of the term "chrysalis" may be noted on p. 59. But in spite of these and other failings the book reaches a high standard of merit, and should appeal to a wide circle of general readers besides those more especially conversant with the subjects of which it treats. F. A. D.

THE CENTURY OF SCIENTIFIC PROGRESS.

The Story of Nineteenth Century Science. By Henry Smith Williams, M.D. Pp. x + 476. Illustrated. (London and New York: Harper and Brothers, 1900.) Price 9*s*.

THE story is worth telling, for whatever the ages may hold in store they can hardly deprive the nineteenth century of the distinction of having witnessed a progress in science without a parallel in the earth's history. Each step in advance has served as a starting-point for many others, and the record of the last quarter century, even of the last decade, far surpasses that of the corresponding period at the outset. The opening chapter of this book, "Science at the Beginning of this Century," enables us to realise how immense the gain has been.

To write such a history is a task on which, at the beginning of the century, an author might have entered with a light heart. Now such an undertaking seems almost an audacity. Scientific omniscience has long become impossible; but in an age of such rapid progress something of the kind is required for a work like this. The reviewer is in a still worse plight. How can he—probably almost wholly occupied in trying to carry some one road a little farther into the unknown land—be competent to decide whether the author has done full justice to those similarly engaged in other directions? So I shall speak critically only of my particular subject, and for the rest briefly touch upon the salient features in the author's narrative. The book, I may remark, evidently had its origin on the other side of the Atlantic, so that the illustrations have a slightly American tinge. The same also may sometimes be said of the English. As example, "down" is a new verb to us; "per hypothesis" jars on the ear; to say that a man was "then only a novitiate in science," startles any one accustomed to employ the word novice. Such solecisms, however, are but few. The chapter on palæontology seems oddly placed between

those on astronomy and geology—surely this, as regards the latter, is a "cart before horse" position. It is also widely separated from biology, with which it is no less closely connected.

We turn, then, to geology, which a century ago could hardly claim to be a science. We find a clear sketch of the principal advances, with some particulars about those who made them, and only in a very few cases are we inclined to dissent. To say that the "strata are level" in the mountains of Sicily [and] the Scotch Highlands is doubtful, unless we are rather liberal in using the term mountain, and is true of only a small portion of the latter region. In speaking of the joint work of Murchison and Sedgwick, the author fails to mention the Cambrian system, and thus does an injustice to the man who independently and accurately established its position. In regard to the Laurentian system, we think that the statement "they are now more generally regarded as once-stratified deposits metamorphosed by the action of heat" would have been truer twenty years ago than at the present time, for the majority of these rocks, we think, are now more commonly considered to have had an igneous origin. While we believe, with the author, that uniformitarian creed must not be so enunciated as to exclude a certain "slowing down," we should hesitate to assert that in any known era

"large areas were rent in twain and vast floods of lava flowed over thousands of square miles of the earth's surface, perhaps at a single jet; and, for aught we know to the contrary, gigantic mountains may have heaped up their contorted heads in cataclysms as spasmodic as even the most ardent catastrophist of the elder day of geology could have imagined."

But with a crust much thinner than it has been in later geological ages, fracture would be more easy and catastrophic disturbances less intense, because more frequent. At any rate, the facts of geology, so far as we can remember, do not support this statement, and Lord Kelvin, who is quoted in its favour, once used the simile of the last spurt of a cooling porridge pot to indicate that, owing to the greater resistance of the crust, a local catastrophe might be as severe in a late age as in an early one. Again, we demur to the following statement—if the author is speaking of any known geological age—that the constituents of the early atmosphere "have since been stored in . . . granite." Unless we admit it to have cooled on the earth's surface, how could this rock plunder the atmosphere? But *Ubi plura nitent . . . paucis offendar maculis?* The author gives a clear sketch of the progress of geology and palæontology from infancy to adult manhood. The principal stages of growth are described, even youthful escapades, the age of which is not yet ended, are sometimes chronicled. But for the most part he restricts himself to those hypotheses which have been able to stand the test of time and are now more or less promoted to the dignity of theories.

But the advances in terrestrial and celestial physics have been even more surprising. With the spectroscope to investigate and the camera to record, each being a discovery of this century, sun, stars, comets and nebulæ are yielding up their secrets; the existence of the ether, he nature of light, the relations of the physical forces, are demonstrated—nay, the genesis of worlds and of matter itself are becoming themes for discussion, while immense advances have been made in chemistry and meteorology. The same is true of the biological sciences, which have been almost revolutionised since the appearance of the "Origin of Species," little more than forty years ago. Though, as these pages prove, no one would assert that the last word has been said on evolution, the process, however it may be explained, is a fact, and its consequences have already extended far beyond biology.

The advance is not yet ended. In proof of that we need only point to the marvels of the Röntgen and Becquerel rays—discoveries of the last decade. Problems enough await solution in this century, of which an excellent summary will be found in the concluding chapter. Unless some dark catastrophes await civilisation, like that triumph of savage ignorance which boasted that "the republic has no need of *savants*," many secrets of nature should be discovered before the new century has run its course. Matter, force, energy, life—what problems these four words suggest, perhaps in part inscrutable—but still, even of these our descendants should know more than the wisest of our own age.

Dr. Williams has produced an interesting book, the more so because it is liberally illustrated with portraits of the leaders of science. These, though unpretending, are often good likenesses, the other illustrations being of a more commonplace character. This volume, like White's "Warfare of Science," should be a manual in every course of theological instruction, because the history of the progress of science declares how it has been opposed, in the imaginary interests of religion, by the friends of the latter. In the past the geologist, the biologist, the physiologist have been vituperated and denounced by ignorant champions of theology, whose fears and assertions time has proved equally unfounded. The mistakes of their forefathers will be a lesson of caution to coming generations; for the spirit of ecclesiasticism is not yet extinct, and our successors will have to confront old foes, though perhaps with new faces.

T. G. BONNEY.

VAN 'T HOFF'S PHYSICAL CHEMISTRY.

Lectures on Theoretical and Physical Chemistry. By J. H. van 't Hoff. Translated by R. A. Lehfeldt. Part iii. Relation between Properties and Composition. Pp. 143. (London: Edward Arnold, no date.)

Leçons de Chimie Physique. Par J. H. van 't Hoff. Ouvrage traduit de l'allemand par M. Corvisy. Troisième partie. Relations entre les Propriétés et la composition. Pp. ii + 170. (Paris: A. Hermann, 1900.)

THE English and French translations of the concluding part of van 't Hoff's lectures are now before us. Although this part ostensibly deals with the relations between properties and composition, its scope is really wider than its title, for it includes the discussion of colligative properties, which are not related to composition at all.

The first third of the book is chiefly concerned with volume, pressure and temperature relations as deduced from van der Waals's equation and the critical constants. As a feat of terse and lucid exposition, this section is unequalled in any text-book with which the present

writer is acquainted. The subject is not an easy one, and the reader must bring a certain concentration of thought to its study; but once he has mastered these forty odd pages he will know the bearing of the critical phenomena on physical chemistry with a thoroughness that will leave little room for addition in his subsequent reading, except on matters of detail. The work of Young, Guye, Daniel Berthelot, Mathias, Guldberg, Traube—all receives consideration, and the impression left is one of harmony and completeness, at least from the practical empirical standpoint.

Boiling-points, latent heats and specific heats are next taken up, and the student will be surprised at many a new way of looking at old familiar facts. Under the heading of surface tension, the method of Eötvös and Ramsay and Shields for determining molecular weights is fully discussed, and a theoretical connection shown with Mathias's law of the rectilinear diameter. The section on physical properties concludes with a chapter on refractive indices and dielectric constants.

The second portion of the book is entitled, Relations between Chemical Properties and Composition. Its first subdivision treats of the affinities of elements as displayed in connection with their positive or negative character. The author's views on this important general question are summarised thus: Positive or negative character is defined as the tendency to combine with positive or negative electricity. The extreme positive and negative elements, such as sodium and chlorine, show the strongest affinities, which suggests that their opposite electrical charges play an active part in their chemical combination. Intermediate elements which are neither decidedly positive nor negative, *e.g.* carbon, often show a tendency to combine with themselves which is wanting in the extreme elements. As second consequence of the tendency to combine with electricity, we have the free production of atoms charged with electricity—the ions—in solvents like water which weaken the electrical attraction owing to their high dielectric constant. This breaking up or loosening in its turn entails a facility for reaction which is absent from intermediate elements, carbon compounds, for example, being characterised by great inertness in chemical action. Lastly, the phenomena of affinity are most marked when the atomic weight is small and the atomic volume large.

A study of the affinities manifested by explosive compounds and explosive mixtures is next entered on, and then the influence of the separate elements on the properties of compounds which they enter is taken up in detail. The concluding sections are on the changes in reaction velocity caused by certain elements and groups, and the appearance of entirely new chemical properties occasioned by the conjunction of certain elements.

On looking back through the book as a whole, one notes the circumstance that Parts i. and iii. are better done than Part ii, and that, on the whole, the physical portions are perhaps at a higher level of excellence than the chemical portions. It is everywhere evident, however, that the material has been wrought into form by a powerful thinker, who sees deeper and more clearly into his subject than any of his contemporaries.

A comparison of the English and French translations shows that the former, being more literal, is more difficult to follow than the latter. The freedom of translation in the French version is, however, not attained at the expense of accuracy; indeed, in more than one passage the sense of the original is better given in the French translation than in the English. To translate *dann* by "therefore" or even by "then," when it is merely used for the purpose of enumerating points of the argument (as in p. 89 of the original, and p. 98 of the English version), gives a false impression of logical sequence; and to translate *Affinitätsäusserungen* by "indications of affinity" (same page) is scarcely exact.

To the French version are appended two notes by the translator—one on Dieterici's modification of van der Waals's equation, the other on Kanonnikoff's "real density," derived from the formula of Lorentz and Lorenz.

Whilst strongly recommending the English version to all interested in physical chemistry, the writer would express the hope that in a future edition the three parts will be paged and bound as one volume, that the price will be reduced to a figure more suited to the size of the work and the means of the majority of students, and, finally, that the book will be provided with an index, the want of which in the present edition materially detracts from its usefulness. J. W.

NEW MAPS AND ATLASES.

The "Diagram" Series of Coloured Hand Maps. Designed by B. B. Dickinson, M.A., F.R.G.S., and A. W. Andrews, M.A., F.R.G.S. (London: George Philip and Son, 1900.). Price 1*s.* per dozen maps.

Philips' London School Board Atlas. Edited by G. P. Philip, Jun., F.R.G.S. Pp. 36. (London: G. Philip and Son, 1900.). Price 1*s.*

The London School Atlas. Edited by H. O. Arnold-Forster, M.A. Pp. 48. (London: The London School Atlas Co., Ltd., 1900.). Price 2*s.*, 3*s.* and 3*s.* 6*d.*

GOOD maps are essential to the success of geographical instruction. The best method of obtaining a true knowledge of the relation of the various land and water surfaces of the earth to one another, their relative dimensions, and their distribution in latitude and longitude, is by the use of a good terrestrial globe; but maps are indispensable even when globes are used, for they show in detail what can only be represented upon a small scale on a globe of the size used in schools. Each of the collections of maps, the titles of which are given above, has its good points, and all of them will assist in the intelligent teaching of geography.

The coloured hand maps prepared by Messrs. Dickinson and Andrews are the best orographical maps suitable for school use which have come under our notice. No names are printed upon the maps, but the elevations of the country are represented in five or six grades of colour, and the chief rivers are inserted. With maps such as these before him, a pupil can see at once how the general direction of river flow is determined by difference of level. He can, for instance, follow with intelligent interest the courses of the Ganges and Brahmaputra Rivers from the Himalayas down to their delta and the Bay of Bengal. The grades of colouring of

different levels of land show clearly that the directions taken by these rivers are the only possible courses for water running downwards to the sea. The course of the Amazon and its tributaries across South America can similarly be understood by a glance at the orographical map. There are thirty maps of this kind in the series, and they are uniform in excellence. They thus bring out prominently the importance of land elevation, and used as they are intended to be—for pupils to fill in the details of physical, political and commercial geography—they will be of real educational value. In the absence of relief or contour maps, the "Diagram" series of orographical maps provide an admirable introduction to the study of geographical science. To convey the idea of comparative size, Great Britain or the British Isles is represented in one corner of each map on the same scale as the map itself. The maps can be supplied as lantern slides, as well as in several forms suitable for school requirements.

Among the noteworthy characteristics of Mr. George Philip's atlas are its remarkable cheapness—the price is only 1*s*.—and the selection of important geographical features to which prominence is given. There are in the Atlas forty coloured plates, containing ninety maps and plans, and eight pages of introductory letterpress. Physical features are clearly represented, and the scale is stated under each map. The difficulty of distinguishing between political boundaries and lines bordering physical features has been successfully overcome by printing the former in distinct red lines. The maps have not the common defect of being overcrowded, and they are up to date both as regards the spelling of names and political divisions. To ensure that the pupil understands the meaning of a map, several views and plans are given side by side; and there are also maps of the County of London and the Thames Basin. These special supplementary maps can be modified to suit local requirements. There is no excuse for using obsolete maps filled with confusing and unnecessary details now an Atlas such as that by Mr. Philip is available.

The Atlas edited by Mr. Arnold-Forster is constructed upon the same intelligent principles as the preceding one; the maps are well drawn, beautifully coloured, not overcrowded, and the place-names have been carefully selected. Views, plans and sections are shown under one another in the introductory maps to provide lessons in map reading. There are also maps of the same district on different scales, illustrations of methods of showing elevation, as used in Ordnance Survey maps, and a reduced Admiralty chart of the Needles to show the method of sea-mapping. Several good astronomical diagrams show some of the phenomena connected with the rotation and revolution of the earth, but Map 8 is incorrectly designated the Solar System; for all that comes under this head in it are the earth in its orbit at the equinoxes and solstices, and the lines representing the relative lengths of the diameters of the sun, earth and moon. Following these maps are forty others upon which the various continents and countries of the world are represented according to their physical features or political divisions. Several maps are devoted to the representation of the growth of the British Empire. Dr. A. J. Herbertson contributes some notes on the construction and reading of maps, and teachers will learn from them how the Atlas can best be used and appreciated.

The appearance of these Atlases at about the same time indicates, we hope, that more careful attention is to be paid to instruction in geography in the future than is now given in most schools. The maps represent the best that have yet been prepared at a low price for use by individual pupils, and their adoption can be recommended to all teachers of geography.

OUR BOOK SHELF.

Die Photographie im Hochgebirg. Von Emil Terschak. Pp. xv + 87. (Berlin: Gustav Schmidt, 1900.)

In this neat little book of some 90 pages, the author gives the reader some practical hints, both in word and illustration, as to the road to success in mountain photography. The hand camera is now so generally used, owing to the rapidity of modern lenses, and there are so many of us who like climbing, and who always carry one of such instruments on our tours, that such a book as this, full of practical hints, will be welcomed. Mountain photography is quite an art in itself, and he who is a good picture-maker near the sea level does not necessarily meet with success when some thousand feet or so up. The effects to be portrayed at that height are of quite a different nature. There we have great contrasts of rock and sky, clouds lying at our feet, mists hanging about different hill-sides, and snow-capped peaks and glaciers adding to the beauty of the landscape.

Each of these cannot be immediately reproduced on the photographic plate without either a great experience in the class of work, or a careful study of the labours of others. In this book the author brings together in an enticing manner the chief points to be borne in mind when making a tour. He commences with useful information relative to the packing up of the camera, plates, &c., and then in turn treats of the several conditions under which the photographer is likely to work—such as photographing mountains from a valley or *vice versâ*, mountain groups from a height, clouds, mists, &c. The author accompanies his remarks with numerous excellent reproductions from his own negatives, and in every case gives data, such as the kind of plate used, lens, stop, length of exposure, time of day and year. Every one who is familiar with the German language, and is interested in mountain photography, will be sure to find this a serviceable book.

An Introduction to Vegetable Physiology. By J. Reynolds Green, Sc.D., F.R.S., Professor of Botany to the Pharmaceutical Society of Great Britain. Pp. xx + 459. (London: J. and A. Churchill, 1900.)

One of the needs most widely felt in modern botanical literature has been that of a good intermediate book dealing with vegetable physiology. Although several standard works dealing with this branch of botany are already in existence, they are for the most part of too advanced a character to be of much use to a junior student. It is a matter for gratification that the task of providing such a treatise should have fallen into such good hands as those of Prof. Green, by whom, as might have been expected, the subject-matter has been skilfully handled and admirably illustrated. By wisely avoiding excessive detail, and by duly emphasising from different points of view the various matters of special importance, the author has succeeded in producing a really excellent student's book, whilst the general reader will find the principal topics of current physiological interest presented in a lucid and interesting manner.

Of course it is not to be expected that such a work should be altogether perfect, and if we indicate some of the points which strike us as susceptible of improvement, we do so in the hope that the work may gain still further in value when future editions are called for.

Whilst many of the illustrations are distinctly good, some are very much the reverse, and as an example of the latter class Fig. 40 may be cited, which is excessively bad, and can hardly be said to illustrate the text (which it certainly does not adorn) in any sense whatever. The story of the digestive functions attributed to the leaves of *Lathraea* is now generally discredited, and might as well have been omitted from the text, whilst the somewhat teleological explanation of the red colour in leaves perhaps might at least have been accompanied by suggestions as to the proximate causes of its appearance such as are indicated by Overton's recent experiments. It is, however, against the short chapter on the influence of the environment on plants that we incline to take the greatest exception. The subject is a large one, and can only be adequately, or even usefully, treated by the aid of copious illustrative examples, without which as in the present instance it is apt to degenerate into rather senseless cramming.

Apart, however, from what after all are but minor and easily remedied faults, the book is, as we have already said, a decidedly good one, and its author has displayed such excellent judgment in the selection of his materials in order to meet the special needs of the class of readers for whom it is primarily designed that there will in future be no excuse for that neglect of vegetable physiology which is at present but too common with junior students of botany. J. B. F.

A Text-book of Important Minerals and Rocks, with Tables for the Determination of Minerals. By S. E. Tillman, Professor of Chemistry, Mineralogy and Geology, U.S. Military Academy, West Point, N.Y. Pp. 176. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1900.)

IN this little manual, Prof. Tillman has brought together such fundamental instructions as are necessary to enable a beginner to determine the most commonly occurring minerals and rocks. Three short chapters on crystallography, the chemical characters, and the physical properties of minerals are followed by a series of tables for the determination of 135 common species. In the choice of these species a considerable amount of judgment is shown, though it is obvious that the opinions of an American mineralogist as to what should be regarded as the most important species differ from those of workers in Europe. The tables are on the familiar plan of those of Weisbach, Persifor Fraser, Brush and Penfield, and other well-known authors, and the arrangement adopted is a very simple one. The twenty pages devoted to rocks at the end of the volume are only sufficient to enable the author to give a very slight sketch of petrographic science. The work is worthy of the attention of teachers organising a system of very elementary instruction in determinative mineralogy.

Laboratory Companion for Use with Shenstone's Inorganic Chemistry. By W. A. Shenstone, F.R.S. Pp. vi + 117. (London: Edward Arnold, 1901.)

MR. SHENSTONE'S course of work in inorganic chemistry was noticed in these columns a few weeks ago (January 10, p. 249). Most of the experiments in that book are reprinted in the present volume, together with a number of exercises, and other experiments have been added. A volume suitable for use as a laboratory manual, that is, containing directions and suggestions, without theoretical considerations, has thus been produced. On p. 117 reference is made to a frontispiece showing Fraunhofer lines, but the picture has been omitted.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Compact Method of Tabulation.

IN arranging tables of successive values of a variable quantity, it is often difficult to find a middle course between making the entries too numerous and making the intervals too large. I wish to call attention to a mode of tabulation which, although compact, provides facilities for the accurate deduction of intermediate values.

For convenience of description we may regard the tabulated values as equidistant ordinates of a curve. If the common distance is small enough (which implies that the number of ordinates is large), intermediate values can be deduced by the ordinary method of "proportional parts"—in other words by employing first differences only. If the number of ordinates is diminished by largely increasing the common interval, it becomes necessary to take account of differences higher than the first. We shall suppose the interval to be so chosen that the first three orders of differences—and no more—require to be considered.

A table showing the given values accompanied by three columns of differences presents a formidable aspect; and on the other hand, if the user of the table is left to compute these differences for himself, his labour is materially increased. What I wish to point out is that, without any sacrifice of accuracy, the first and third orders of differences can be omitted, the second only being retained; as in the following table of sines, which is suitable for computing the sine of any angle to four places of decimals. The differences entered opposite the sines are the "central" second differences; for example, −104, which stands opposite to sin 20°, is (sin 30° − sin 20°) − (sin 20° − sin 10°).

Angle	Sine	Second difference	Angle	Sine	Second difference
0°	·0000	− 0	50°	·7660	− 232
10	·1736	− 52	60	·8660	− 263
20	·3420	− 104	70	·9397	− 286
30	·5000	− 152	80	·9848	− 299
40	·6428	− 196	90	1·0000	− 304

Let $u_0\ u_1$ be any two consecutive tabulated ordinates (sines) between which it is desired to interpolate a new ordinate u; $x_0\ x_1\ x$ being the corresponding abscissas (angles). Putting h for the common interval $x_1 - x_0$, let p stand for $\frac{x - x_0}{h}$, and q for $\frac{x_1 - x}{h}$, so that $p + q = 1$. Also let $u_0''\ u_1''$ denote the central second differences of $u_0\ u_1$ respectively. Then it can be shown that the value of u true to third differences is

$$pu_1 + \frac{p(p+1)(p-1)}{1 \cdot 2 \cdot 3}u_1''$$
$$+ qu_0 + \frac{q(q+1)(q-1)}{1 \cdot 2 \cdot 3}u_0''.$$

The sum $pu_1 + qu_0$ of the two terms in u_1 and u_0, though it does not put first differences in evidence, really includes them, and is the exact value of u when the connecting curve is a straight line. In like manner, though third differences are not in evidence, they are implicitly contained in the sum of the two terms in $u_1''\ u_0''$.

The coefficients of $u_1''\ u_0''$ are identical in form, and are easily computed. The following list of their values for each tenth of an interval will serve to check mistakes. Their values (neglecting sign) are always less than ·065.

$$\frac{p(p+1)(p-1)}{1 \cdot 2 \cdot 3}$$

p		p		p	
·1	− ·0165	·4	− ·0560	·7	− ·0595
·2	− ·0320	·5	− ·0625	·8	− ·0480
·3	− ·0455	·6	− ·0640	·9	− ·0285

Two examples will show the working of the method.

To find sin 36°, we have $p = \cdot 6$, $q = \cdot 4$.

$$
\begin{aligned}
\cdot 6\ (\cdot 6428) &= \cdot 38568 \\
\cdot 4\ (\cdot 5000) &= \cdot 20000 \\
\cdot 064\ (\cdot 0196) &= \cdot 00126 \\
\cdot 056\ (\cdot 0152) &= \cdot 00085 \\
\hline
& \quad \cdot 58779 \quad \text{say } \cdot 5878.
\end{aligned}
$$

To find sin 72° 30′, we have $p = \frac{1}{4}$, $q = \frac{3}{4}$, giving $-\frac{5}{128}$ and $-\frac{7}{128}$ as the coefficients of $u_1'' u_0''$. Hence we obtain

$$
\begin{aligned}
\tfrac{1}{4}\ (\cdot 9848) &= \cdot 2462 \\
\tfrac{3}{4}\ (\cdot 9397) &= \cdot 70478 \\
\tfrac{5}{128}\ (\cdot 0299) &= \cdot 00117 \\
\tfrac{7}{128}\ (\cdot 0286) &= \cdot 00156 \\
\hline
& \quad \cdot 95371 \quad \text{say } \cdot 9537.
\end{aligned}
$$

Both these results are correct to the last figure.

The formula of interpolation here employed (which can be carried to higher terms when necessary) seems to be new. I gave it to Section A at the last meeting of the British Association, and have illustrated its use more fully in the *Journal of the Institute of Actuaries* for last month (January). It will also appear with other kindred matter in the next number of the *Quarterly Journal of Mathematics*. J. D. EVERETT.

Frost Fronds.

ON the morning of January 29, as I was walking from this place down Haverstock Hill into London, about 9.30, my attention was attracted by the "frost fronds" on the flags of the footpath. I see instances not unfrequently, and have called attention to one variety, where they form divergent groups, like the sticks of a partly opened fan, resembling the well-known crystals of actinolite obtained on the southern side of the St. Gothard Pass (see *Proc. Roy. Soc.* lxiii. p. 217, and *Quart. Journ. Geol. Soc.* liv. p. 368); but those now mentioned were characterised by unusual delicacy and grace. They formed groups, often half a yard in diameter, composed of frond-like radiating tufts, made up of thin stems or acicular crystals (often some four inches long and about the thickness of a bodkin) beautifully curved: this almost invariable bending of the "blades" being the most marked characteristic. They resembled very delicate seaweeds, dried and displayed on a card as an ornamental group. In descending the hill I observed that the crystals became a little coarser and more like those already mentioned. Also that sometimes clots of frozen mud appeared near the junction of the fronds, as if a trefoil or quatrefoil leaf had been placed there to hide it. I attribute the unusual delicacy of the fronds to the fact that the previous evening had been showery, and so the pavement had been cleaned of all but the very finest mud, after which had come a drying wind and a frost. Thus crystallisation probably occurred in a very thin film of slightly turbid water and on a fairly smooth surface, so that opposition to it was comparatively slight and the circumstances approached more nearly to the crystallisation of water on glass. I could not linger to make a minute study as I was pressed for time, but write this in the hope that some one who can take photographs (which I cannot) will collect examples of "frost fronds," for I believe they would be helpful in interpreting crystal building in rock masses. T. G. BONNEY.

23 Denning Road, Hampstead, N.W., January 31.

The Total Solar Eclipse of May 17–18.

THE Board of the Koninklijke Natuurkundige Vereeniging at Batavia has applied to the Government in regard to the custom duties to be levied from scientific observing parties who may visit the Dutch colonies for the observation of the total solar eclipse on May 17–18. The following reply has been received.

No duties will be levied on goods not exempted by the tariff, but destined to be re-exported after the observation of the eclipse has been concluded; observing parties may obtain further information from the chief Custom House officer at the port of arrival.

Besides all possible facilities in having their goods imported, exemption from search will be afforded to scientific expeditions.

We feel much pleasure in bringing the above under the notice of intending observing parties. J. J. A. MULLER.

January 1. (President of the Kon. Natuurk. Ver., Batavia).

The Museum of the Institute of Jamaica.

IN connection with your items regarding the possible return of Dr. J. E. Duerden, curator of the Jamaica Institute Museum, to England, may one who has spent two summers in Jamaica engaged in zoological research, and who has enjoyed the hospitality of Dr. Duerden and other men of science there, be permitted to say a word as to the causes which have led to the present unfortunate situation? There are two such principal causes, I believe, not closely related, but in this case working together toward a common end. The most important of these is local jealousy, against which Dr. Duerden has had to contend constantly ever since his arrival at the island. At the time he was appointed, a large and influential element among the supporters of the Institute desired the appointment of a young Jamaican, who had received some training in England, and who was doubtless well qualified for the duties of the position. His failure to secure the office was a bitter disappointment, not only to himself, but to his friends, and Dr. Duerden entered on his duties with an unfortunately large number of hostile critics, watching for opportunities to find fault. It is very possible—in fact, since Dr. Duerden is human, it is highly probable—that opportunities for criticism arose, and possibly the criticisms have not always been met in the wisest possible spirit. But it is clear to me, and I think I can speak for all the Johns Hopkins men who were in Jamaica, that if Dr. Duerden's local critics had been as anxious to help him and build up the museum as they were to find fault, there would be no trouble at the present time. I do not mean to say that Dr. Duerden has been entirely blameless, but I feel sure that his responsibility for the trouble is very much less than that which rests on his critics. The fact that Dr. Duerden is a trained investigator, and has given a large share of his time to research work, has given opportunity for criticism from those who believe the curator ought to devote his time to adding new specimens to the exhibition collection and labelling them all properly.

The other cause of the proposed retrenchment is one which appeals to me strongly, and must, I think, to all unprejudiced persons who know the facts. The colonial expenses are greater than the income, and the debt is already heavy. A very large proportion of the expense account is made up of salaries paid the English civil officials, from Governor down. The Governor receives a salary of 6000*l.*, besides two residences and the usual perquisites of his position. This salary is grotesquely enormous under the circumstances. Jamaica is not only a delightful place to live in, a veritable paradise in many respects, but it is a very cheap place as well. I should estimate, from my slight experience there, that living expenses are about three-fifths of what they are in the eastern United States. Most Englishmen in Jamaica do not realise or believe this, for they still cling to English food and English customs. Now the colony, a few years ago, attempted to secure the reduction of the salaries of colonial officials, and suggested a saving of 1000*l.* on the Governor's salary, but the proposition was promptly ended by that official's veto, which is absolute. So every attempt to decrease expenses by decreasing salaries has failed, and now retrenchment has to come somewhere, and since a zoologist is of small account, especially one who has some powerful enemies, Dr. Duerden is to be sent back to England. If this event actually takes place the blame will rest, not on Jamaica, but on England. There is little chance for the advance of scientific research in that island so long as it is looked on by English politicians as a possession to be exploited for the benefit of the office-holders.

I trust it is not yet too late for the scientific men of England to make such an emphatic protest to the proper authorities that the Board of Governors of the Jamaica Institute may be compelled to retain Dr. Duerden as curator of the museum, if he can be persuaded to stay, and if not, to secure some equally competent and well-trained investigator to fill his place.

HUBERT LYMAN CLARK.

Olivet College, Michigan, January 15.

The Mongoose in Jamaica.

IN Jordan and Kellogg's admirable little book, "Animal Life," we read (p. 293):—"The mongoose, a weasel-like creature, was introduced from India into Jamaica to kill rats and mice. It killed also the lizards, and thus produced a plague of fleas, an insect which the lizards kept in check."

As it is evident from this and other signs that the Jamaica mongoose is to become celebrated in text-books, it seems worth while to call attention to the facts actually known about it. An excellent summary showing the status of affairs in 1896 was written by Dr. J. E. Duerden and published in the *Journal* of the Institute of Jamaica, vol. ii. pp. 288–291. In the same volume, p. 471, are further notes on the same subject.

The creatures which increased and became a pest were ticks; not fleas. The present writer can testify to their excessive abundance in the island in 1892 and 1893. The species were various, and were examined by Marx and Neumann, whose determinations appear in *Journ. Inst. Jamaica*, vol. i. p. 380, and vol ii. p. 470. It will be noted that the common species are not confined to Jamaica, and, in fact, have probably, most of them, been introduced from elsewhere. Hence it is quite possible that their abundance is in large part due to their recent introduction.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., January 17.

Thermochemical Relations.

LET us consider gr. 2 of H, gr. 16 of O and gr. 71 of Cl, namely, volumes 2 of H, 1 of O, 2 of Cl. We can combine these corps two by two to form the three following compounds:—

gr. 87 of Cl_2O gr. 18 of H_2O gr. 73 of HCl

that occupy respectively 2, 2, 4 volumes.

The heats of combination are respectively:—

$$-14 \qquad +58 \qquad +44,$$

between which is the simple relation

$$-14 + 58 = 44.$$

In another example, where one of the components is solid but remains the same ratio between the volumes of the compounds, we have again the same relation between the combining heats. In fact, with

gr. 2 of C gr. 4 of H gr. 32 of O

we can form

gr. 16 of CH_4 gr. 44 of CO_2 gr. 36 of H_2O

which occupy respectively 2, 2 and 4 volumes.

The combining heats are respectively

$$+19 \qquad +97 \qquad +116,$$

and we find

$$19 + 97 = 116.$$

Is it a casual coincidence or a law?

Spezia (Italy), Nov. 14, 1900. CARLO DEL LUNGO.

Direction of Spirals in Horns.

ABOUT Mr. Blanford's interesting remarks on my letter in NATURE for January 10, I should like to answer that, far from thinking the matter "simple," I find that the facts are nowhere recorded and certainly are not generally known to naturalists or sportsmen. This is why I attempted to formulate rules.

The rule that in antelopes the direction of the spiral is "crossed" (*i.e.*, the right horn is sinistral, and the left horn is dextrorsal) holds good in the Koodoos, Elands, Indian antelope, Bushbuck, Impalla, and Speke's antelope (noted by me in the *Lancet*, January 1, 1898, "On Spiral Growth").

In oxen the horns are "homonymous" in direction—the right horn twists to the right, the left horn to the left—and many horns show a good spiral. I may mention the Cape buffalo, musk ox, domestic ox, also the Urus and the Chartley bull. The only exception to the rule in the Cambridge Museum is an Indian buffalo.

In the sheep, the direction of the spiral is "homonymous," as in the ox, except *Ovis orientalis* and *Ovis nahura*.

In the goats, Mr. Blanford, in his "Fauna of British India, Mammalia," notes that there is a difference between the wild and the tame goats in the following passage: "But the spiral in tame goats is almost always in the reverse direction to that found in Markhor, the anterior ridge in the tame animals turning inwards at first in each horn.

"I have, however, seen exceptions; there is one from Nepal in the British Museum."

After searching many books on horns (including Mr. Lyddeker's), this is the only note on the direction of spirals that I can discover. The causes of the spirals, and of the differences in directions, are still to seek.

Cambridge. GEORGE WHERRY.

SOME DISPUTED POINTS IN ZOOLOGICAL NOMENCLATURE.

AMONG that large section of the general public who are interested, to a greater or less degree, in natural history there is a widely spread impression that, as most of the more familiar animals have a single, definite and indisputable popular designation, so every known species in the animal kingdom has one proper technical title by which it is known throughout the zoological world; and consequently that when they have once made themselves acquainted with this title, there is no more to be said on the subject. To a certain limited extent (some authorities would, perhaps, be inclined to say invariably) there is no doubt that this idea is perfectly well founded. But, in the first place, there is a difference of opinion among zoologists as to the limits of genera, and whereas one worker would retain a species in the genus in which it was placed by its original describer, another would regard it as entitled to represent a genus by itself. Thus one great element of diversity in nomenclature is introduced.

But there are also a very large number of cases in which an equal diversity of view obtains as to the proper specific title of an animal. And the inquirer will not be long in ascertaining that, in place of unanimity, an almost chaotic state of uncertainty prevails as to what should be the proper binomial designation of a large percentage of animals. Consequently, in place of being one of the easiest, the question of nomenclature is, in many cases, one of the most difficult; and the unhappy inquirer will too often find that he receives a different answer from almost every authority to whom he applies. Nor is this all, for whereas a considerable number of systematic zoologists are agreed in some measure upon certain general principles of nomenclature, their opinions are not shared by many of the workers in palæontology, morphology and geographical distribution, who adhere to more antiquated views on these questions.

The reasons for this regrettable and unfortunate state of affairs are many and varied. And as a crisis on the question is likely to arise in the near future, if indeed it be not already upon us, the editor is of opinion that there are many readers of NATURE who would like to be informed of some of the chief points at issue, and of the more important suggestions which have been made towards arriving at a settlement. It will consequently be understood that the present article has been written solely from this point of view, and that it makes no pretence to discuss all the questions, or to enter into details interesting to zoologists alone.

One of the points at issue—and it is one of the most important—is what we may term the theory of the sacredness and immutability of the specific name. Soon after Linnæus had completed the last edition of the "Systema Naturæ" published under his own personal supervision, it became apparent that a large number of the animals named by him could no longer be permitted to remain in the genera in which they were included in that work. The giraffe, for example, which had been named *Cervus camelopardalis* by the Swedish naturalist, was certainly entitled to generic distinction from the deer. At this date the idea of the "sacredness" of the species name had not yet originated, and Gmelin, in his edition of the

"Systema Naturæ," considered himself justified in "promoting" the specific title *camelopardalis* to generic rank, and proposing a new specific name for the animal thus designated. *Cervus camelopardalis*, Linn., thus became *Camelopardalis giraffa*, Gmelin. Similarly, in much later years, Gray changed the *Antilope strepsiceros* of Pallas into *Strepsiceros kudu*. According, however, to the modern school of zoologists, such changes were totally unjustifiable; and they hence advocate what is known as the "*Scomber scomber*" principle, on which the title of the kudu becomes *Strepsiceros strepsiceros*. To many (among them the secretary of the Zoological Society) such tautological titles are most repugnant; and in the case of the animal last mentioned they accordingly prefer to retain the title proposed by Gray. In the case of the giraffe, by a fortunate circumstance, the difficulty does not arise, for the generic title *Giraffa* had been proposed at an earlier date than the "promotion" of *Camelopardalis*, and the name of the animal consequently became automatically *Giraffa camelopardalis*. If the "sacredness" of the species name be insisted upon, and the tautology objected to, a way out of the difficulty in the case of the kudu and many other analogous instances might be found by making a new generic title, when the animal might be called *Kudua strepsiceros*. But the case of the striped hyæna, the *Canis hyaena* of Linnæus, then arises as an example of another difficulty. For this animal was subsequently named *Hyaena striata*, altered by the modern school to *Hyaena hyaena*; and if we refuse to accept the latter and yet desire to retain the original species name, we have to abrogate such a familiar generic title as *Hyaena*, and likewise the family name *Hyaenidae* (for there are but few who would advocate the retention of a family name when the generic title from which it is derived is abolished). The older naturalists, in the absence of any law to the contrary, considered themselves perfectly justified in promoting the specific title to generic rank, and personally we fail to see on what grounds the present generation think themselves entitled to override this decision, as, in our own opinion, there is no right or wrong in the matter. That similar changes are now forbidden is, of course, fully understood.

But bad, in the opinion of many, as is the tautology of *Strepsiceros strepsiceros*, worse is to follow. By those who admit the principle of "trinomialism" to designate local races of animals, if the kudu were divisible into two or more such races the typical form would, according to American writers, become *Strepsiceros strepsiceros strepsiceros*. And, again, if the lesser kudu were subgenerically separated from the larger species, the title of the typical race of the latter would become *Strepsiceros* (*Strepsiceros*) *strepsiceros strepsiceros!* We do not like to use the term absurdity in connection with the views of others, but it becomes almost difficult to refrain.

That some designation is advisable for local races of species is admitted by nearly all, but there is still a reluctance among many to accept the aforesaid trinomialism. To many such the interpolation of the word "var." between the specific and the racial title appears preferable; and to this plan there can be no objection, albeit it is somewhat more cumbersome. It must, however, be borne in mind that when the word "var." is inserted the third title must agree in gender with the species name, whereas in trinomialism proper it agrees with the genus name. To avoid tautology, many zoologists use the designation "typicus" for the type race of a species, but this usage is objected to by others in that it is practically a new subspecific title.

This, again, leads us to notice a modern change in regard to subgeneric titles. Formerly, when a genus was divided into subgenera, a new subgeneric name was proposed for the typical group, *e.g. Cervus* (*Eucervus*) *elaphus* for the red deer. Now, however, the practice is to repeat the generic name, as instanced above in the case of the kudu. In this connection it may be noticed that even those who object to the "*Scomber scomber*" principle come perilously near to it when subgeneric terms are employed, as in *Cervus* (*Dama*) *dama* for the fallow deer, which they would call *Dama vulgaris* if regarded as a separate genus. It should likewise be mentioned that the bracketing of a name is only admissible when it is used in a subgeneric sense, as above. Consequently the practice of indicating a synonym in this manner, *e.g. Microtus* (*Arvicola*), is totally unjustifiable, although it is frequently practised by biologists other than systematists.

The mention of *Microtus*, the title now employed by the modern school to designate the voles in place of *Arvicola*, which was in almost universal use a few years ago, brings us to the vexed question of priority. Although there are still many zoologists who adhere to the practice of using names (both generic and specific) which, in spite of not being the earliest, have been current in literature for a long period, the general trend of opinion is all in favour of the enforcement of the rule of priority (even to the bitter end) among systematists. In the main, it must be confessed that the advocates of this have reason on their side, as otherwise we are landed in almost hopeless difficulties. But admitting the general principle to be the most logical, may there not be room for the exercise of some discretion and common sense? A naturalist, for instance, years ago described, from a cave in America, what appears to be an upper premolar tooth of the white-tailed deer, to which he gave the name *Odocoileus*, on the supposition that it represented an unknown type of animal. As a matter of fact, he ought to have referred it to the genus *Cervus*, as that genus was then understood. Yet American naturalists propose to adopt this name for the white-tailed deer and its allies. Such usage is a premium on incompetence and ignorance; and it does not seem fair that names so given should supersede those proposed by workers who know their business. Of course there are many difficulties when the discretionary element is once introduced, but, like all others, they are not insuperable when properly handled.

One of the greatest evils arising from the wholesale change of names that has been introduced of late years through this revival of the right of priority is that it renders obsolete to a great extent works such as Dr. Wallace's "Geographical Distribution of Animals"—works that ought to stand for all time. It further involves the task of recollecting a double series of names if such works are not to be cast aside *in toto*. It is largely on this ground that so many biologists other than systematists refuse to conform to the new view. The evil induced by the change is undoubtedly great and much to be deplored; but it will certainly not be remedied by the refusal of one section of workers to follow in the footsteps of those of their brethren who alone have full opportunities of arriving at the best decision with regard to a matter bristling with difficulties.

From priority in nomenclature the transition to the question of preoccupation is an easy one. That the use of a generic name in botany is no bar to its employment is now generally conceded; but it is considered advisable that such names should be given as seldom as possible. Most zoologists are likewise agreed that when absolutely the same name has been once employed as the generic designation of any group of animals (whether it be in use or not), it cannot be employed for another. There is, however, a want of unanimity as to whether the same name with a different termination—*e.g. Hydropotes* and *Hydropota*, or *Mastodon* and *Mastodus*—may be used for two groups. Closely connected with this is the question whether the transliteration or grammatical formation of names should be amended—*e.g. Machairodus* to *Machaerodus*, or *Megatherium* to *Megalotherium*; and

whether, if they are not so amended, the use of both is admissible for different groups. Some even go so far as to say that an obvious error in the spelling of a name, as, for example, *Rhinchosaurus* in place of *Rhynchosaurus*, should not be amended, and that the previous use of the incorrectly spelt name should be no bar to its subsequent employment for another group in the correct form. To many, at least, of those who have even the slightest knowledge of the classics such a practice must be repugnant. And to a certain extent, at any rate, the same remark will apply to hybrid names, although the general consensus of opinion is now against the amendment of these. Less objection can be taken to meaningless names, or anagrams (such as *Xotodon*, the anagram of *Toxodon*), which, if euphoniously formed, serve their purpose fairly well. And the old objection against so-called barbarous names has of late years been waived by many workers. Although it is by no means a general view, such names are more euphonious when Latinised, as *Linsanga* in place of *Linsang*, and *Coendua* for *Coendou*. Then again there are names like *Camelopardalis* (giraffe), *Hippotigris* (zebra), and *Hippocamelus* (a deer), given on the supposition that the animals to which they refer are intermediate between the two indicated by the compound title. The two former have late classical authority, and may further be justified on account of the coloration of the animals to which they refer, but to some persons, at least, the acceptation of the third is objectionable. It must be confessed, however, that when once individual fancy is allowed play in matters of this sort, it is difficult to know where to draw the line.

Another class of names are those which have been given to species on the evidence of maimed specimens, or examples whose place of locality was incorrectly recorded. The great bird-of-paradise was thus named *apoda*, while the name *ecaudatus* has similarly been applied to at least one mammal. Again, a bear inhabiting the Himalaya has been named *tibetanus*, while there are even more flagrant instances of misapplied geographical titles. Many workers of the modern school assert that no errors of this kind should be amended; while some would even say that although Tibet is the accepted modern way of spelling the country of the lamas, yet that if the specific title was originally spelt *thibetanus*, so it must remain for all time. A common-sense, rather than a pedantic, view can, we think, be the only safe guide in such cases. When a name inculcates an error in geographical distribution, its retention, from this point of view, is clearly indefensible. So, again, in the case of names due to misconception or maimed specimens. Where, for instance, the name *ecaudatus* denotes a long-tailed animal, its retention is against common sense. On the other hand, where the feet of a bird are inconspicuous, as in the swift, no great exception can be taken to the use of the name *apus*.

The last point in dispute to which we have space to refer is the right of an author to withdraw a name proposed by himself in favour of some later title. A well-known instance of this is afforded by the name *Daubentonia*, proposed by Geoffroy in 1795 for the aye-aye, but, on account of preoccupation in botany, subsequently withdrawn by him in favour of Cuvier's name *Chiromys* (or *Cheiromys*, as it was originally spelt). Whereas the right of withdrawal was denied by Gray (and the older name revived), by Sir William Flower it was admitted. The modern tendency is to follow Gray. If the preoccupation of a zoological name by a botanical were now admitted, of course Geoffroy's change would be followed. The question is whether, being right according to the views of his own time, there is sufficient justification for saying that he acted *ultra vires*. Moreover, the possibility is to be borne in mind that the next generation of zoologists will revert to the view that the use of a generic term in botany bars its subsequent employment in the sister science.

To arrive at a settlement in regard to these and many other points in dispute will require forbearance and the subordination of individual inclinations to the voice of the majority; compromise and common sense being, we venture to think, at least as necessary as adherence to inelastic rules.

In the foregoing we have purposely refrained from making any reference to Mr. H. M. Bernard's proposal to abolish specific names in those forms of life "which cannot be at once arranged in a natural system," for the reason that, if we understand him aright, it is his intention that the abolition in question should apply only (for the present, at any rate) to corals, sponges, and perhaps other low types of invertebrates. Whatever, therefore, may be its merits or demerits, the proposal is not yet intended to apply to such forms of life as are capable of being arranged in some approximation to a "natural system"; and the discussion of the disputable points in connection with specific names alluded to above is accordingly not yet rendered superfluous.

R. L.

CHARLES HERMITE.

AMONG those mathematicians who assisted in making the nineteenth century, and more especially the Victorian era, a period of unparalleled activity in the scientific world, the name of Charles Hermite will be indelibly imprinted in our annals as that of one who did much to develop the study of higher algebra, geometry, analysis and theory of functions.

Charles Hermite was born at Paris in 1822, and at the age of twenty he entered the École Polytechnique. His mathematical genius was not long in showing itself, for shortly afterwards we find him corresponding, at the instigation of Liouville, with Jacobi on the subject of Abelian functions, and the predictions of the latter mathematician that Hermite would soon extend the fields of study which he himself had done so much to open out was soon verified. From the theory of continuous functions Hermite soon passed on to the theory of forms, and gave a general solution of the problem of arithmetical equivalence of quadratic forms. He also discovered a new arithmetical demonstration of Sturm's and Cauchy's theorems on the separation of roots of algebraic equations.

The study of higher algebra, which sprang into existence with the discovery of invariants, was opened up simultaneously by Cayley, Sylvester and Hermite, and it would appear that to the latter mathematician we are indebted for the law of reciprocity, the discovery of associated covariants and gauche invariants, and the formation of the complete system of covariants of cubic and biquadratic forms and invariants of the quintic. Concurrently with these researches in arithmetic and algebra, Hermite was engaged on the study of the transformation of hyperelliptic functions and expansions of elliptic functions, and he was also the first to show that the number of non-equivalent classes of quadratic forms having integral coefficients and a given discriminant is finite. In 1856 Hermite was elected to the Institut, being then thirty-four years of age. In 1858 he took an important step in connection with the study of elliptic and theta functions by introducing a new variable connected with the q of Jacobi by the relation $q=e^{\iota\pi\omega}$, so that $\omega=\iota k'/k$. He was then led to consider the three modular functions denoted by $\phi(\omega)$, $\chi(\omega)$ and $\psi(\omega)$.

A transcendental solution of the quintic involving elliptic integrals was given by Hermite, the first paper appearing in the *Comptes rendus* for 1858 and subsequent papers in 1865 and 1866. After Hermite's first publication, Kronecker, in a letter to Hermite, gave a second solution, in which was obtained a simple resolvent of the sixth degree.

We are also indebted to Hermite for the first proof that e, the base of the Napierian logarithms, is transcendental, a result which paved the way for Lindemann's proof that the same is true of π.

In 1862 Hermite was elected to a newly founded chair at the École Normale, and later on he also became professor at the École Polytechnique and the Sorbonne. Instead of continuing to teach on the old lines which he found still in vogue, Hermite introduced into his lectures the great discoveries of Gauss, Abel, Jacobi and Cauchy. He thus founded for France a new school of higher geometry, and the large number of mathematicians of distinction who have studied under him bear abundant testimony to the success of his innovation.

During the later period of his life Hermite appears to have directed his attention more especially to questions connected with the calculus. In conjunction with Darboux and Jordan, he presented the general theory of linear differential equations in an entirely new light, choosing the algebraic rather than the geometric method of presentation. His work on Lamé's equation leads to the solution of a large number of problems in applied mathematics.

The "Cours de M. Hermite" constitutes an important work on the theory of functions.

About eleven years ago Hermite delivered an inaugural address before the President of the French Republic, which was published in the *Bulletin des Sciences mathématiques* for January 1890. In 1892 he celebrated his jubilee, and it is remarkable that the same year witnessed also the jubilee of Pasteur. The new century and the new era in history which has come upon our country will both be the poorer for the loss of M. Hermite, but his works will be handed down to posterity.

An account of his work has been given in the *Comptes rendus* for January 21 by M. C. Jordan, himself the author of important papers on the fields of study which Hermite had chosen to work in. To this account we are indebted for much matter contained in the present notice, and we are glad that M. Jordan pleads for the publication of Hermite's collected works. Many of his ideas are scattered in journals or letters that are difficult of access, and it will be of inestimable use to mathematicians to have them printed in book form.

G. H. B.

ADOLPHE CHATIN.

ADOLPHE CHATIN died on January 13 at the age of eighty-seven. He was a native of Dauphiné, and was born at Ile-Marianne-de-Saint-Quentin, near Tullins, "d'une famille peu fortunée," according to M. Gaston Bonnier, from whose éloge in the *Comptes rendus* of the Paris Academy (January 21) some of the following facts of his life-history are taken. He received his early education at Tullins, and at seventeen joined an apothecary at Saint-Marcellin. Three years later (1833) he went to Paris under an apothecary named Briant, who, recognising his pupil's capabilities, urged him to study pure science as well as pharmacy. Chatin, who always gratefully remembered his good friend's advice and encouragement, worked to such effect that he took bachelors degrees both in Letters and Science, and six years after his arrival in Paris obtained the degree of Doctor of Science. In the next year, 1840, he read his thesis before the School of Pharmacy, and was duly admitted. The somewhat ambitious title of this thesis, "The Comparative Anatomy of Plants applied to Classification," indicated the line of work in which he has done most service to botany. It was a short paper dealing with the occurrence, structure and general properties of albumen in plant-seeds. He took the view that the presence of endosperm in the seeds, implying a temporary arrest in the embryogeny of the plant, indicates a lower condition than that existing in the exalbuminous seed. "From this time," he tells us in the introduction to the "Anatomie Comparée des Vegetaux," "comparative anatomy was (with plant symmetry) the principal object of my labours."

In 1844 he took the degree of Doctor of Medicine, and in 1848 was elected to the chair of Botany at the School of Pharmacy, his chief competitor being M. Payer. Twenty-five years later he became Director of the School, retiring in 1886 with the title of Honorary Director. In 1874 he was chosen a member of the Academy of Science, succeeding Claude Gay, and in 1897 became President of the Academy. He was also a member of the Academy of Medicine, and filled various other posts of honour.

His first memoir, published in 1837, was on the symmetry of structure of plant organs, and sixty years later appeared the last part of his studies on the symmetry of the vascular bundles of the petiole. His best-known work is the "Anatomie Comparée" (1856-1862), which was never completed. It consists of two parts, the larger illustrated by 113 plates, on Dicotyledonous Parasites, the smaller with 20 plates, on Aquatic Monocotyledons. It is difficult to estimate the value of this work. Its chief worth lies in the beautifully executed figures illustrating the anatomy of the stem, leaf and root of a large number of genera and species. Their preparation implies considerable skill and much hard, conscientious labour, with which the results, as embodied in the text of the book, are scarcely commensurate. But it is hard to judge the work of forty years ago from our present standpoint, and in helping to revive the study of plant-anatomy, which had fallen into neglect, Chatin did good service, and might well, in his later years, regard with some complaisance and pride its present important position as one of the factors in the evolution of a natural system of plant-classification.

Chatin also studied the organogeny of the flower, especially of the andrœcium, and collected the results of numerous small papers, which had previously appeared in the *Comptes rendus* and elsewhere, in a volume entitled "De l'Anthère" (1870)—a comparative account of the development, structure and mode of dehiscence of the anther in a number of families and genera. His memoir on the life-history and structure of *Vallisneria spiralis* is a useful piece of work, illustrated with characteristic elaborate detail. But he by no means restricted himself to the study of the symmetry and anatomy of plants; the subjects of his published works and papers comprise the results of chemical as well as botanical investigations. Among his earlier papers were several dealing with the occurrence of iodine in air and water, its presence in plant tissues and its effect on plant growth. He also wrote on the potato disease, the vine disease, and on the cultivation of truffles and other edible fungi, and published a small book on watercress.

For the past two years his health, hitherto robust, had been gradually failing, and his last days were spent in retirement at his country home at Essarts-le-Roi, near Rambouillet. His son, M. Joannes Chatin, a professor at the Sorbonne and a member of the Academy, has made a few contributions to botanical literature, but his work has been chiefly in other branches of science.

NOTES.

ARRANGEMENTS are being made by the Royal Academy of Sciences of Sweden to celebrate the third centenary of the death of Tycho Brahe, the founder of modern practical astronomy, on October 24, 1901, by a special meeting. It is also proposed to further commemorate Tycho's work by the publication of a facsimile of the original edition of his celebrated "Astronomiæ instauratæ mechanica," a perfect copy of which is in the library of the Academy. It is well-known that when at Wandesburg

in the year 1598, Tycho had this work printed in his own office, with the view to give the celebrities of his time an exact idea of the organisation of the observatory which he had left for ever. But the edition appears to have been small, for the only copies of the work now known to be in existence are two at Copenhagen, and one each at the British Museum, Prague, and Stockholm. Another edition was printed four years later at Nuremberg, but it is not nearly so fine as that printed by Philip de Ohr at Wandesburg. Subscriptions are invited for the facsimile of the Stockholm copy of the work, and should be sent to Prof. Hasselberg, Royal Academy of Sciences, Stockholm, Sweden, before March 1. The price is fixed at 2*l*. a copy.

THE gold medal of the Royal Astronomical Society has been awarded this year to Prof. Edward C. Pickering, of Harvard College Observatory. The medal will be presented at the annual general meeting of the Society, which will be held at 3 p.m. to-morrow (Friday).

ON January 28 Scottish geology lost a most successful and enthusiastic fossil-collector in Mr. James Bennie, who then passed away at the ripe age of seventy-eight years. He began, while an artizan, in early life to employ his leisure hours in gathering fossils from the Carboniferous formations around Glasgow and from the Glacial deposits of the West of Scotland. So successful were these excursions and so excellent his published descriptions of the results obtained from them that in the spring of 1869 he was invited to join the Geological Survey of Scotland as Fossil Collector. He was thenceforth able to devote his whole time to work which had previously been only possible for him in his scanty hours of leisure. His career in the Survey was marked by remarkable industry, insight and success. He acquired a more minute knowledge of the palæontological stratigraphy of the Carboniferous system than was probably possessed by any one else. He discovered the first recognisable traces of *Holothuria* in that system, and obtained remains of scorpions from many different horizons. To his acute faculty of observation we owe the first recognition of the little Arctic *Apus* among the deposits of lakes of the Glacial Period in Scotland. He was not only a lynx-eyed collector but wrote well, and supplied many interesting papers to the *Transactions* of the Geological Societies of Edinburgh and Glasgow. He was fond of English literature, and when too poor to purchase Tennyson's Poems, borrowed a copy and transcribed it all. The value of his work was recognised two years ago by the Geological Society of London, which awarded him the Murchison Fund. His gentle and kindly nature, his cheery helpfulness and his loyal devotion to duty made him a great favourite with his colleagues, from whom he retired in 1897 on a well-merited pension.

AT University College, London, last week Prof. Schäfer was presented with a testimonial subscribed for by a number of those who had been his pupils or who had worked in the physiological a boratory during his tenure of office as Jodrell Professor of Physiology. From a report in the *British Medical Journal*, we learn that the chair was taken by Prof. Thane, who sketched the main features of Prof. Schäfer's connection with University College, and spoke of the esteem in which he was held alike by pupils and colleagues. The presentation was made by Dr. Leonard Hill, F.R.S., who, in a short and sympathetic speech, referred to the way in which Prof. Schäfer had stimulated physiological inquiry, and won, not only the respect, but the affection of those who were privileged to learn from him or to work under him. The presentation took the form of a bowl and two platters of hammered silver, designed and made by Mr. Alexander, of University College School, and of a cheque for a sum of money which is to be devoted to founding a medal to be given for the encouragement of physiological research in University College. Prof. Schäfer, who was very warmly received, said that the occasion recalled to him another occasion in the same theatre some thirty years ago. He then learnt from the lips of Sharpey that he had won the medal in physiology, and received it from the hands of Huxley. He believed that that circumstance had determined him to follow physiology as a career.

DR. R. A. DALY, of the Department of Geology and Geography of Harvard University, is endeavouring to organise a geological and geographical excursion in the North Atlantic for the summer of 1901. Conditionally on the formation of a sufficiently large party, a steamer of about 1000 tons, specially adapted for ice navigation, and capable of accommodating sixty persons, will leave Boston on or about June 26 and return to the same point on or about September 20. The main object of the voyage will be to offer to the members of the excursion party opportunity of studying the volcanic cones and lava-fields, the geysers, ice-caves and glaciers of Iceland, the fiords and glaciers of the west coast of Greenland, and the mountains and fiords of Northern Labrador. Some attention will be paid to the hydrographic conditions of the waters traversed. Botanists, zoologists, ornithologists, mineralogists and persons interested in other branches of natural history may pursue independent studies. A hunting party may take part in the expedition; it could be landed for a fortnight or three weeks in Greenland and for about the same period in Labrador. Explanatory lectures on the regions visited will be given from time to time by the leader of the excursion, Dr. Daly, who will also act as guide on the Labrador coast, where he spent the summer of 1900. An inclusive fee of 500 dollars for each member will be charged, 250 dollars to be deposited with the leader of the expedition on or before March 15. Applications for membership should be addressed to Dr. R. A. Daly, Harvard University, Cambridge, Mass., U.S.A.

WE regret to have received information of the death of the Nestor of European botanists, Dr. J. G. Agardh, of Lund, who died on January 17 in his eighty-eighth year. Prof. Agardh was chiefly known for his work in marine algæ. He was a correspondant of the Section of Botany of the Paris Academy of Sciences.

A NATURAL History Section has been formed of the Hampstead Astronomical and Scientific Society, with the primary object of working out the local fauna and flora. Meetings of the section will be held from time to time, when exhibits will be made, papers read, and discussion on zoological and kindred subjects invited. The honorary secretary for the section is Mr. J. W. Williams, 128, Mansfield Road, Gospel Oak, N.W.

MR. WILLIAM H. CROCKER, of San Francisco, has offered to defray the expenses of a solar eclipse expedition to be sent by the University of California from the Lick Observatory to Sumatra to observe the total eclipse of the sun on May 17. An astronomer and assistants will sail from San Francisco on February 19, to be absent until July. It is proposed to establish an observatory camp somewhere within twenty miles of Padang, on the west coast of Sumatra.

THE "Historical Number" of the *Electrical Review* of America (January 12) is full of notes and articles of interest to students of electricity. The number contains several very readable and informing papers on various branches of electrical work, and a series of portraits of men who contributed to the progress of electrical science and industry during the past century.

WE learn from *Science* that Mr. J. W. Sprague, who died recently, left a will that should ultimately greatly benefit the Smithsonian Institution. It gives 85 per cent. of the interest on

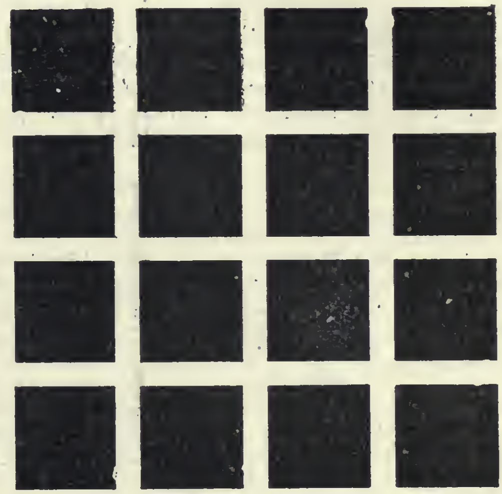
the estate to relatives for life. On their death the entire property, increased by 15 per cent. of the income to be laid by each year, is held in trust for twenty years, and then reverts to the Smithsonian Institution. One-half of the annual income is then to be added to the principal each year, and the other half is to be used for the advancement of the physical sciences by prizes, lectures or original research. It is estimated that the fund now is worth 200,000 dollars, and that it will be available in about fifty years.

DR. NORMAN MOORE will deliver the Harveian Oration of the Royal College of Physicians of London on St. Luke's Day, October 18, and Dr. Judson S. Bury, of Manchester, the Bradshaw Lecture in November. Dr. W. H. Corfield has been appointed the Milroy Lecturer for 1902. A subscription of fifteen guineas has been voted by the College to the fund for erecting a statue of Dr. William Gilbert, a former president, in the new Town Hall of Colchester. The adjudicators of the Weber-Parkes Prize for 1900 have reported that they have been unable to find any original work, published since the last award, which in their judgment would satisfy the conditions of the trust. Dr. J. F. J. Sykes will deliver the Milroy Lectures on February 28 and on March 5 and 7, on "The Influence of the Dwelling upon Health"; Dr. H. Head, F.R.S., the Goulstonian Lectures on March 12, 14 and 19, on "Certain Mental States associated with Visceral Diseases in the Sane"; and Dr. J. Frank Payne the Lumleian Lectures on March 21, 26 and 28, on "Cancer, especially of the Internal Organs."

FREE railway transport is granted to members of the staff of the New Mexico Agricultural Station engaged in experimental work and investigation, by the principal railway companies of the territory. This, remarks Dr. F. W. Sanders in a report just to hand, will enable the station to serve the public interests more perfectly than it has been possible to do in the past. Mr. A. Goss concludes, from results obtained during three years, that a number of districts in New Mexico can produce remarkably good beets, both as to sugar content and purity. Prof. T. D. A. Cockerell, the Station entomologist, who has for a number of years interested himself in the pigments of insects and plants, refers to a red colouring matter of the roots of the small borraginaceous plant *Eremocarya micrantha*, which may prove of service the properties of the pigment. The pigment belongs to the anthocyan series, and behaves exactly like litmus, turning red in the presence of acids, blue in the presence of alkalies. It is superficial on the roots, and readily soluble in cold alcohol. This pigment is thus an excellent native subs itute for litmus, and might possess commercial value. Not only is it purer than commercial litmus, but its preparation is very much simpler, and the roots are easily obtained. The matter is now being further investigated by the Division of Botany of the U.S. Department of Agriculture, and we shall doubtless be informed of the results before very long.

WE have received from Dr. Hergesell, President of the International Aëronautical Committee, an account of some preliminary results of the balloon ascents made on January 10. There were 15 ascents, including both manned and unmanned balloons; of these three started from Vienna, four from Berlin, and four from Strassburg. Altitudes varying from 4500 to 12,000 metres were attained by the unmanned balloons and some very low temperatures were registered. Three of the manned balloons ascended above 3000 metres. Several inversions of temperature with height were recorded—*e.g.* Vienna, 23°·7 at 500 metres, 34°·2 at 1000 metres, 32°·4 at 2000 metres; at Berlin, 25°·5 at starting, 32°·0 at 790 metres, 41°·0 at 1460 metres, 32°·4 at 2825 metres, while at 6670 metres the temperature had fallen to −22°·0. Ascents were also made at London and Bath, but the results are not given in Prof. Hergesell's summary. One of the balloons from Berlin, with Messrs. Berson and Hildebrandt, descended in Sweden after a flight of nearly fourteen hours.

A CURIOUS optical illusion is produced by the accompanying figure from *La Nature*. At the places where the white strips separating the black squares cross one another, a hazy penumbra can be seen. If, however, attention is concentrated upon one



of these spots it disappears, though the others remain visible. It would be interesting to vary the dimensions of the squares and intervening white spaces, and thus determine when the effect ceases to be seen.

THE thermal death-point of the tubercle bacillus is the subject of an important paper by Messrs. Russell and Hastings in the "Seventeenth Report of Wisconsin Agricultural Experimental Station." The general results obtained entirely confirm the experiments of Prof. Theobald Smith (see NATURE, vol. lxiii. pp. 166 and 205), and are as follows:—"(1) Exposure of tuberculous milk in a tightly closed commercial pasteuriser for a period of ten minutes destroyed in every case the tubercle bacillus, as determined by inoculation experiments (*i.e.* at a temperature not exceeding 68° C.). (2) When milk is exposed under conditions which would enable a pellicle to form on the surface, the tubercle bacillus may resist the action of heat at 60° C. for considerable periods. (3) In order to thoroughly pasteurise milk without injuring its creaming properties or consistency, it should be heated in closed pasteurisers for a period of not less than twenty minutes at 60° C. Under these conditions, it is certain that disease bacteria such as the tubercle bacillus will be destroyed without the milk or cream being injured in any way."

There has been considerable diversity of opinion concerning the ethnic affinities of the Slavs, and Zaborowski returns to the subject in a recent number of the *Bulletins et Mémoires de la Société d'Anthropologie* (5), I., 1900. His view is that the Slavs belong to the same race as the Celts of French anthropologists, that is, being brunet brachycephals, they are members of the Alpine race. Their original home was that which is still occupied by the southern Slavs between the Danube and the Adriatic, and they were allied to the inhabitants of the Terramara of Emilia. The northern Slavs migrated along the valley of the Vistula and reached the shores of the Baltic, where they developed a civilisation and introduced in this region the practice of burning their dead, which was previously unknown there; they also brought with them metals and glass.

Wherever the Slavs migrated they introduced the custom of incineration, and carried with them the characteristic metal head-rings, the ends of which terminated in sigmoid curves (Hackenringe). The settlement of the Venede on the Baltic dates back to the fourth century, B.C. The Baltic Slavs were profoundly affected by the expansion of the Germans about the beginning of our era, but apparently not till the eighth century A.D., did the slavs colonise Northern Russia.

MR. R. SHELFORD, of the Sarawak Museum, has sent us a copy of his paper in the October number of the *Ibis*, describing the arrangement of the down and plumage in the embryos and young of *Centropus sinensis*—an aberrant cuckoo. Certain differences from the arrangement obtaining in the allied *C. celebensis* are noticed.

THE sixth fasciculus of vol. v. of the Memoirs of the Boston (U.S.) Society of Natural History is devoted to an elaborate memoir by Mr. R. P. Bigelow on the anatomy and development of the medusa known as *Cassiopea xamachana*. In common with the allied *Polyclonia frondosa*, this is a form specially modified for a sedentary existence in shallow water among mangrove roots.

WE have received the Report of the Museums Association for 1900, containing the account of the meeting held at Canterbury in July last under the presidency of Dr. Henry Woodward. It is satisfactory to learn that this useful association is in such a flourishing condition that it has to consider how best to spend its surplus income. The Report includes the President's address, together with twelve papers and various notes. Mr. F. A. Bather gives specimens of descriptive museum labels for certain groups of echinoderms, but the extreme technicality of these suggests that they are suited for a zoological text-book rather than for the ordinary public. A heading like "CRYPTOBLASTUS, E. AND C," is calculated to mystify rather than enlighten the uninitiated. In his address, the President dwells on the difficulty of amalgamating the recent and fossil zoological collections in the British Museum owing to the constitution of the Staff.

THE abstract of a paper by Dr. W. H. Gaskell on the origin of the eyes of vertebrates and the meaning of the second pair of cranial nerves appears in the November issue of the *Proceedings* of the Anatomical Society. After stating that the ancestor of the vertebrates possessed a pair of diverticula from the fore part of the alimentary canal with which the ganglia of the retina and the optic stalks of the lateral eyes were connected, the author pointed out that such a pair of blind diverticula exist in generalised crustaceans, such as *Branchipus* and *Apus*, adding that there is a connection between these diverticula and the retinal ganglion. It is therefore assumed that similar structures existed in the extinct trilobites. From this and other evidence it is inferred that the origin of the vertebrate eye is traceable to an animal derived from the trilobite stock, such as was abundant when the fish-like cephalaspids made their appearance.

THE horary values of the magnetic elements (declination and horizontal force) at Copenhagen, in the years 1895–1896, are given by M. Adam Paulsen in the *Annales* de l'Observatoire magnétique de Copenhague, just received from the Denmark Meteorological Institute, of which M. Paulsen is director.

THE Sanitary and Economic Association, Ltd., Gloucester, have sent us a pamphlet published by them for the purpose of promoting the economy of coal, the abatement of smoke, and the diffusion of an elementary knowledge of the first principles of warming and ventilating generally.

PROF. S. P. THOMPSON'S interesting story of "Michael Faraday: His Life and Work," published in the Century Science Series, is now available in the popular edition at the low price of half-a-crown. The book was reviewed in NATURE of June 8, 1899 (vol. lx. p. 123). Messrs. Cassell and Co. are the publishers.

MESSRS. SAMPSON LOW, MARSTON AND CO. have published the sixth edition of Mr. N. E. Yorke-Davies' little book on "Health and Condition in the Active and the Sedentary." The book contains a clear statement of the laws of health, with special reference to the dietetic treatment of ailments due to errors in eating and drinking.

ONE of the most remarkable catalytic agents recently discovered is metallic nickel, reduced from its oxide at a low temperature. Two or three years ago MM. Sabatier and Senderens showed that this metal is capable of causing the direct combination of hydrogen with ethylene and acetylene, ethane being formed in both cases. In the current number of the *Comptes rendus* they now show that reduced nickel is a very active catalytic agent, so far as the addition of hydrogen is concerned surpassing even spongy platinum. Thus a mixture of hydrogen and benzene vapour, passed over reduced nickel at about 200° C., readily gives hexahydrobenzene, no benzene escaping conversion if the hydrogen is in excess. The reaction appears to be a general one, since the homologues of benzene behave similarly; nitrobenzene is reduced to aniline.

THE phenomenon of birotation of the sugars has given rise to a considerable amount of work without any very definite results being obtained. In the current number of the *Zeitschrift fur physikalische Chemie* there is a paper, by Dr. Yukichi Osaka, on the birotation of *d*-glucose, which throws much light upon this subject, and forms an interesting application of the dissociation theory of solution. From the velocity constants of the change of rotation of *d*-glucose, both alone and in presence of acids, bases and neutral salts, it is shown that this sugar acts as a weak acid, the velocity of the change of rotation being proportional to the concentration of the hydroxyl ions, and to the square root of the concentration of the hydrogen ions.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, presented by Mr. J. Coombes; two Black-necked Swans (*Cygnus nigricollis*) from Antarctic America, a Yellow-rumped Parrakeet (*Platycercus flaveolus*) from Australia, three Blue-fronted Amazons (*Chrysotis aestiva*) from South America, deposited.

OUR ASTRONOMICAL COLUMN.

VARIATIONS IN THE MOTION OF THE TERRESTRIAL POLE.—In the *Astronomical Journal* (vol. xxi. No. 489), Prof. S. C. Chandler investigates the data available for determining the changes in the annual elliptical component of the polar motion. References to these changes have been previously made in *A. J.* Nos. 422 and 446, but no decisive conclusions could then be made. The data are taken from the records at Pulkowa, Leyden, Washington, Berlin, Cambridge and Madison, and are grouped for two epochs, 1865, 1883. From each series the effect of the 427-day term of the latitude variation is eliminated after correction to a uniform value of the aberration constant and stellar parallax; from the residuals the constants of the annual term of the latitude variation are found, and finally, by combining these constants for all the series at each epoch, the elemen of the ellipse are computed for 1865 and 1883.

The present article considers all records prior to 1890, and the result indicates that the line of apsides is revolving from east to west, or in a direction contrary to that of the pole in its orbit, in a long period of some 75 years—*i.e.* at a rate of about 5° annually; also that the length of the annual period oscillates about its mean value, the fluctuations having a long periodical character, with a cycle of about 60 years.

DEFINITIVE ELEMENTS OF THE ORBIT OF COMET 1898 VII.—Nos. 3684, 3685 of the *Astronomische Nachrichten* are devoted to an exhaustive discussion, by Mr. C. J. Merfield, of Sydney, of the data recorded for the comet discovered by Mr. Coddington at the Lick Observatory on June 11, 1898. Some 400 observations are utilised, the largest series being those made by Mr. Tebbutt at Windsor, New South Wales.

Epoch of Osculation 1898 *June* 21.

T = 1898 Sept. 14·0442056 G.M.T.

$$\left.\begin{array}{l} \omega = 233^\circ\ 15'\ 18''\cdot66 \\ \Omega = 74\ \ 0\ \ 58\cdot17 \\ i = 69\ \ 56\ \ 0\cdot37 \end{array}\right\} 1900\cdot0$$

$$\log q = 0\cdot2308587.$$
$$\log e = 0\cdot0004487.$$
$$e = 1\cdot0010336.$$

OBSERVATIONS OF EROS.—Several observers are now commencing to publish their lists of measures of the planet Eros, made during the recent opposition. In the *Astronomische Nachrichten* (Bd. 154, No. 3683), Prof. A. Abetti gives a long list of measures taken during July, August, September, October and December 1900 at Arcetri-Firenze.

M. J. Pidoux also contributes a series obtained during October and November 1900 at Geneva, and Signor A. Antoniazzi others during July and August 1900 at Padova.

PHOTOGRAPHIC CATALOGUE OF POLAR STARS.—The first issue of the *Publications of the Vassar College Observatory*, U.S.A., contains a catalogue of sixty-five stars within one degree of the North Pole, reduced by Miss C. E. Furness from photographs obtained with the 13-inch Helsingfors astrographic refractor. A discussion of the results in a manner suggested by Prof. Jacoby, of Columbia University, led the conclusion that, within the limits of the plates—2° square—no optical distortion was to be detected.

AUDIBILITY OF THE SOUND OF FIRING ON FEBRUARY 1.

ON Friday last, between three and four in the afternoon, the body of our lamented Queen was conveyed from Cowes to Portsmouth past a fleet consisting of some of the finest battleships of the world. The minute-guns fired from these vessels during the passage of the funeral procession were clearly heard at great distances from Spithead; for, from the regularity of the discharges, there can be little doubt as to the origin of the reports.

We have received several letters referring to the sounds heard at various places. Prof. E. B. Poulton, F.R.S., writes as follows from Youlbury, Boar's Hill, near Oxford:—

"During the interval between three and four o'clock on the afternoon of Friday, February 1, many people on this hill, about 520 feet above sea-level, including Mr. Arthur J. Evans and I, heard the sound of distant guns. The period over which the sounds were heard, the direction from which they appeared to come, the mode of their occurrence in groups separated by intervals of silence, led us to believe that they were the guns of the fleet ranged between Cowes and Portsmouth, and that each group of sounds represented the salute of a single ship as it was passed by the Royal Yacht. Judging from an old atlas the distance appears to be about sixty-seven miles in a straight line. The afternoon was bright and sunny and the air very still. The sounds could be distinctly heard in the house with closed windows. Out of doors they were really impressive. It is probable that other records will reach you, indicating that they were noticed at much greater distances."

Prof. F. J. Allen and Mr. C. Thwaites heard the reports very distinctly at Sutton, Surrey, which is about sixty miles from Portsmouth, and the latter states that the windows of a house were slightly shaken with each discharge.

Several letters from correspondents who heard the sounds have appeared in the *Times*, the *Standard* and the *Daily News*. Towards the east, the booming of the guns was distinctly heard at Beachy Head (60 miles from Spithead), near Brightling (69 miles) and Woodchurch (84 miles); towards the east-north-east, near Tunbridge Wells (66 miles); towards the north-east, at Wallington (59 miles), Croydon and Richmond Hill (62 miles), and Bexley (75 miles); towards the north-north-east, near King's Langley (74 miles); and towards the north, at Marcham (near Abingdon, 64 miles), Great Missenden (69 miles), Oxford (70 miles), Witney (73 miles), and Leighton Buzzard (84 miles). The concussion was sometimes strong enough to shake windows at Wallington, Richmond Hill and Great Missenden. Near Brightling, cock-pheasants crowed as they do during a thunderstorm. As a rule, there appears to have been little or no wind to interfere with the propagation of the sound-waves.

JUPITER AND HIS MARKINGS.

JUPITER is now visible as a morning star, and observers have resumed their investigations of his surface markings. The coming opposition on June 30 will not be a favourable one for telescopists in Europe, as the planet will be in about 23 degrees of south declination, and therefore at a very low altitude.

The lingering relics of the great red spot, situated within the hollow in the south side of the southern equatorial belt, will probably be a difficult feature in the circumstances. But it should be carefully looked for, and its times of transit across the central meridian of the planet noted as frequently as possible. These will occur during February, about 80 minutes after the times given for the zero meridian (System II.) by Mr. Crommelin in his ephemerides published in the *Monthly Notices* for December 1900. Whenever the red spot itself cannot be distinguished, it will be advisable to take the time of transit of the hollow in the belt, which is a very easy object. In recent years the rotation of the spot and hollow has exhibited a slow decrease of speed, amounting to about one-tenth of a second annually. In 1896 the period was 9h. 55m. 41·3s., in 1900 9h. 55m. 41·8s. On February 15, 1901, the longitude of the spot will be about 48°, if the retardation has continued. Its easterly drift will bring it into longitude 51°·5 on June 15, 1901, and 61°·5 on June 15, 1902.

With regard to the equatorial spots, these have shown a mean motion of about 9h. 50m. 24·1s. during the past three years, and this is about six seconds shorter than the period adopted for System I. in the ephemerides above referred to.

The study of Jupiter during the present year may have a special significance, for it is likely to throw an important light upon the question whether or not certain features on the disc are recurrent at pretty regular intervals. There is a belt in about 23° north latitude which displayed some remarkable outbreaks of spots in 1869, 1880 and 1890, and a similar phenomenon is now again due if such outbreaks are periodical and owe their origin to some disturbing action repeated on the planet at intervals of about a decade. The features alluded to move more rapidly than any other markings observed on the disc. The same, north temperate, belt is often marked with small dark spots or condensations, but these travel with normal velocity and differ little from the rate of the red spot. There is another current in this region conforming with a period of 9h. 56m., which is probably slower than any other Iovian current. In the southern hemisphere, south of the red spot, there are two well-pronounced streams translating their various markings along at rates of 9h. 55m. 19s. and 9h. 55m. 7s. for a complete circuit.

Among other details offered by the planet may be mentioned the colours of the belts and their relative intensity and distribution over the disc. The value of continuous observation of the forms and motions of the markings in various latitudes is very great. It is only by collecting a mass of results during many consecutive years that proper investigation can be made and the various changes in progress assigned their proper periods. Until quite recently observations were somewhat irregular and altogether insufficient for a complete discussion of the phenomena. During the coming opposition observers in the southern hemisphere will have the planet well placed, and ought to be able to supply any deficiencies in the results obtained at northern observatories.

W. F. DENNING.

AGRICULTURE IN THE WEST INDIES.

THE third annual Agricultural Conference, under the presidentship of Dr. Morris, Commissioner of the Imperial Department of Agriculture for the West Indies, was held in the Legislative Chamber, Bridgetown, Barbados, on January 5. Besides Dr. Morris, the president of the Conference, and some fifty official, scientific, agricultural and educational representatives from the various West Indian colonies, there were present the Acting Governor, a large number of officials and representatives of the Legislature, and visitors.

After the usual preliminary formalities, Dr. Morris delivered his presidential address, which afforded a clear summary of the progress made by the Department of Agriculture for the preceding year and enumerated the questions which this Conference would be invited to discuss. The work of the officers of the Department during the preceding year covered a wide range. In the domain of the sugar industry it comprised researches to improve the sugar cane, experiments to reduce the cost of cultivation, efforts to advance the erection of central factories and researches upon insect and fungoid diseases, including an exhaustive investigation and monograph by the entomologist, Mr. H. Maxwell Lefroy, on the moth borer (*Diatraea saccharalis*).

Besides the work of the Department on the cacao industry and the lime industry, an attempt had been made, with prospects of success, to establish the growing of early potatoes for the English market; a small but promising onion industry had been established in Antigua, and there was every reason to believe that the fruit trade between Jamaica and the United Kingdom would receive an enormous impetus by the subsidising a direct fruit steamer service between the Mother Country and that Colony.

Agricultural education had occupied a large share of attention; the teachers of the elementary schools of nearly all the colonies were being trained by courses of lectures and demonstrations to teach the elementary principles of agriculture in their schools; seven exhibitions, of value varying from 10*l*. to 75*l*. per annum, had been awarded to pupils from first grade (public) schools in the various islands which were tenable at Harrison College, where a two years' course in agricultural science was given by the Science Department, Barbados. Agricultural industrial schools had been opened at St. Vincent and Dominica.

Nine botanic stations were now supported by Imperial funds, and a large number of experimental stations had been instituted in the various colonies, where experiments were being systematically carried out on questions connected with the sugar cane and all the other products of the West Indies.

Agricultural shows had been successfully carried out in three of the islands under the auspices of the Department, which had contributed 350*l*. in prizes and more than one hundred diplomas of merit.

The address concluded with some remarks upon the subject of the treatment of diseased plants, and upon the advisability of legislation with a view to prevent the introduction of plant disease into colonies from without, and to provide for the eradication of disease within the colonies.

The following papers were read during the Conference:—

Sugar Industry: Recent experiments with seedlings and other canes, by Prof. d'Albuquerque and Mr. J. R. Bovell (Barbados), and a short history of seedling canes in Barbados, by Mr. J. R. Bovell (Barbados), followed by a discussion in which representatives from all the colonies took part; cane farming in Trinidad, by Prof. Carmody (Trinidad); insect pests of sugar cane, by Mr. H. Maxwell Lefroy, entomologist of the Department; fungoid diseases of the sugar cane, by Mr. Albert Howard (Barbados).

Educational: Agricultural education and its place in general education, by Rev. Canon Simms (Jamaica); teaching the principles of agriculture in elementary schools, by the Hon. T. Capper (Jamaica); results of ten years' experience with compulsory enactments in the Leeward Islands, by Mr. C. M. Martin (Leeward Islands).

General:—Legislation to control bush fires, by Dr. H. Nicholls (Dominica); the treatment of soils in orchard cultivation in the tropics, by the Hon. Francis Watts (Leeward Islands); on rubber planting in the West Indies, by Mr. J. H. Hart (Trinidad); pine-apple cultivation at Antigua, by the Hon. Francis Watts (Leeward Islands); the marine resources of the West Indies, by Dr. J. E. Duerden (Jamaica); bee-keeping, by Mr. W. K. Morrison, the acting bee expert of the Department; the cultivation of onions at Antigua, by Mr. Wm. Sands; zebra cattle in Trinidad, by Mr. J. H. Hart and Mr. C. W. Meaden; artificial drying of cacao, by Mr. G. Whitfield Smith; and experiments on the treatment of insect pests in 1900, by Mr. H. Maxwell Lefroy. These papers, together with the discussions that followed them, will be produced in the *West Indian Bulletin*, the official organ of the Imperial Agricultural Department for the West Indies.

The Chemical Section of the Conference, adjourned from the previous year, drew up a report dealing chiefly with uniformity of records in reports upon sugar cane experiments. The Educational Section held a meeting to consider matters connected with the teaching of agriculture in elementary and first grade schools, including the compilation of teachers' handbooks.

J. P. D'ALBUQUERQUE.

NATIONAL ASPECTS OF SCIENTIFIC INVESTIGATION.

AS a rule, the recognition of scientific work by the State is the last matter with which men of science concern themselves. Their work is sufficient for them, and they are content with the results obtained, whether appreciated or not at the proper value to the commonwealth; they are the victors, but they leave the spoils to others. Most true investigators are inspired by this unselfish sentiment, rather than by the desire for personal profit, and all they ask for is the adequate provision of means for research. Even this request is not urged with the persistency necessary to produce effect. It must be remembered that the general public, as well as the persons who have it in their power to encourage investigation by granting subsidies and extending other facilities, do not understand the fundamental importance to the nation of contributions to the store of natural knowledge. When they appreciate the fact that scientific work furnishes the motive power of industrial progress, they will regard it in a more serious and liberal spirit than at present. For this reason no opportunity should be lost of reminding the State of its duties and responsibilities as regards scientific work, the claims of which are not urged with sufficient force by the men engaged in it. Scientific societies and associations in Great Britain interest themselves in the advancement of natural knowledge, but it might be well occasionally to hold a meeting for the purpose of stating some of the relationships between research and national welfare. Such a meeting was held recently at Baltimore, by the American Society of Naturalists, and addresses on the attitude of the State toward scientific investigation were given by Prof. H. F. Osborn, Prof. W. Bullock Clark, Dr. L. O. Howard, Dr. B. T. Galloway and Prof. W. T. Sedgwick. The following extracts from the remarks made upon this occasion are abridged from the report in *Science*.

In the course of the remarks with which the discussion was opened, Prof. H. F. Osborn said:—

A fair criterion of intelligence in the government of a country is afforded by an examination of its annual budget. There is first the provision for a certain number of expenditures which are purely conservative, because the State must maintain itself, it must defend itself, it must support a large class of office-holders who are more or less useful. These expenditures may be wisely and honestly made, but they largely go to waste; they are either immediately productive or altogether non-productive. On the other hand, there are expenditures in the nature of investments, looking to the future and characterising the most far-sighted statesmanship. Conspicuous among these are the funds invested in education and science.

Said Helmholtz in 1862: "In fact men of science form, as it were, an organised army, labouring on behalf of the whole nation, and generally under its direction and at its expense, to augment the stock of such knowledge as may serve to promote industrial enterprise, to increase wealth, to adorn life, to improve political and social relations, and to further the moral development of individual citizens. After the immediate practical results of their work we forbear to inquire; that we leave to the uninstructed. We are convinced that whatever contributes to the knowledge of the forces of nature or the powers of the human mind is worth cherishing, and may, in its own due time, bear practical fruit, very often where we should least have expected it."

Of European countries Germany places in its budget the largest productive investments of this kind; France is not far behind, England is perhaps fourth and affords a conspicuous

example of blindness and fatuity in the matter of unproductive investment; she has, it is true, established textile schools, but has not sufficiently supported technical schools; the cost of a single battleship would establish four splendidly equipped technical schools; England secures the ship and postpones the construction of the schools. All this is through no fault of her prophets of science, who have been as persistent as Jeremiah in foretelling the consequences which are sure to follow.

Yet England gave Darwin his schooling upon the *Beagle;* and Huxley secured his upon the *Rattlesnake.* As a seafaring nation, marine zoology appeals to her imagination, and the single notable departure from her short-sighted policy in the encouragement of pure science is the magnificent service she has rendered in the *Challenger* expedition. Our own Dana was trained upon the Wilkes expedition; the French Government equipped the *Talisman;* the German Government is supporting the highly successful cruise of the *Valdivia* and its publications under Chun; the U.S. Government has a permanent exploring vessel in the *Albatross.*

In this rivalry of foresightedness the German and French Governments have been our keenest competitors both on sea and land, and have probably surpassed us in the recognition of the ultimate economy of pure research. Germany's most admirable recent action is the subvention of Prof. Abbe for his investigations upon optics. Abbe's work was not in the nature of invention, but of research and discovery in the highest sense, resulting in the production of an illuminating stage, apochromatic and achromatic immersion lenses, which have fairly revolutionised biology. What we owe to these lenses in a theoretical sense could not be stated in a single volume, and the economic value is equally immeasurable.

The distinctive feature of pure science is that it is not remunerative; the practical rewards and returns are not the immediate objects in view. On the other hand, the work of Tyndall and Pasteur on fermentation, pursued in the first instance for its own sake, has come to have an economic importance which is simply incalculable.

American legislators have lent a willing ear to the advice of wise men. What we now enjoy we owe mainly to the counsels of Joseph Henry, Spencer F. Baird and G. Brown Goode. And I may call attention here to a thought which will be expanded presently, namely, that the secret of the success of these men is to be found in their enthusiasm, unselfishness and lofty scientific and personal character. When we consider the liberal appropriations made year after year for the United States Geological Survey, the nobly equipped station at Wood's Holl, the purely scientific work which is now being supported by many States and municipalities, there is abundant cause for congratulation. . . .

Prof. W. Bullock Clark dealt chiefly with the power of legislators, cooperation between national bureaux and University institutions and the preparation of men by universities for State work. He said :—

It may perhaps be desirable to examine for a moment the reason why scientific investigation is not and cannot be self-supporting. This may be found in the fact that the great majority of scientific researches have no immediate commercial value and as commodities cannot find a speedy or, in most instances probably, even a prospective market. We all know of many investigations, begun without thought of pecuniary advantage, that have ultimately produced practical results of the greatest importance. Instances might be cited of investigations the value of which were not apparent until a generation or more had passed, as, for example, palæontological researches which have laid the foundation for the correlation of deposits of great economic value. The support of such investigations must be looked upon as investments for the State which no far-sighted statesman will ignore.

We find that ever since the establishment of universities and seminaries widely over Europe in the fourteenth and fifteenth centuries, the civilised countries of the world have recognised in one form or another the relation of the State to scientific investigation. Not only the great nations of the world, but oftentimes the small and relatively poor countries like Belgium and Switzerland, as well as the smallest of our own commonwealths, have frequently provided liberally for the support of scientific research. This has been accomplished through the publicly endowed educational institutions, through the public museums and through the special bureaux of the Government.

Too frequently scientific investigation has held a subordinate place in both the publicly and privately endowed institutions, their chief functions being either educational or commercial. The purpose of the schools and universities is primarily in most instances the instructing of youth in the already acquired results of scientific research rather than the fostering of investigation for itself, although the latter as a secondary consideration often holds a prominent place in the larger institutions of learning. The museums and scientific bureaux are, like our great universities, centres of research, without the exactions of teaching, where continuous investigation can be pursued under most favourable conditions, although here again either educational or commercial considerations for the most part ostensibly control. That this is not always the case is cause for congratulation, and the support of research directly for itself without other, and oftentimes false, claims is becoming yearly a more fully recognised fact.

It is interesting for us who are Americans to know that the claims of science received recognition at the very inception of our Government, for we find that George Washington in his first message to Congress stated: "Nor am I less persuaded that you will agree with me in opinion that there is nothing more deserving your patronage than the promotion of science and literature. Knowledge in every country is the surest basis of public happiness. In one in which the measures of government receive their impressions so immediately from the sense of the community as ours it is proportionately essential." How well that early advice has been carried out by the statesmen of later days under the wise counsels of Henry, Baird, Goode and their successors, Prof. Osborn has already shown. . . .

The various bureaux and divisions of the U.S. Department of Agriculture, the U.S. Geological Survey and the U.S. Coast and Geodetic Survey are all manifesting a broad spirit of helpfulness that is being met by the State and university institutions. The possibilities of an extension of this co-operation between Nation, State and University promise well for the widening of the bounds of scientific investigation in this country. It is indeed a hopeful sign when we see the scientific men of the nation, whatever their affiliations, working together with mutual interest and respect. May it presage the dawn of a still brighter day in American science.

Dr. L. O. Howard spoke more particularly upon the ultimate practical importance of pure scientific work from the point of view of applied entomology, and the preparation of men for the scientific work of the State. He said :—

It is upon work in pure science that the entire superstructure of economic entomology has been built, and workers in applied science are constantly making use of the results of the labours of workers in pure science. The practical outcome, however, of the labours of the workers in pure science is indirect, while the practical outcome of those who work in the economic applications of science is direct. In any emergency the direct method is the one which is immediately productive of practical results. The study of economic entomology is a study of facts which will enable us to meet one great and widely extended emergency. It must be conducted by the direct method, and the reason why this country stands in advance of the rest of the world in this application of science is because we are a practical people and have adopted the direct method. There can be no doubt, however, that it is necessary for the most successful economic worker to have had a sound training in pure science. . . .

Men in charge of university departments of scientific work should keep closely in touch with the Government work along similar lines. They should be encouraged to do this by the Government. Government should employ their services wherever they can be of use, and such cases are numerous. They themselves should be able, with the intimate knowledge acquired by official association or by close investigation of Government work, to lay out lines of study which will fit their students to take a hand in Government work. In many cases, of course, this cannot be thoroughly done in university laboratories at the present time. . . .

The U.S. Department of Agriculture is the first of the Government bureaux which does economic zoological work. Good research work and initiative in investigation are encouraged. Nothing could be more ideally perfect than the relation between the present head of the Department of Agriculture and his scientific corps. Four years ago he announced his policy in this regard in conversation with one of his scientific chiefs in the following words :—"I am here to facilitate your work, not to dictate to you. Make your plans, conduct your investigations,

and I will help you with all my strength, but I shall hold you responsible for results." Scientific men should honour James Wilson for the introduction of this novel principle in the administration of a Government scientific bureau . . . .

The old popular idea of a scientific man—that he lacks what is called "common sense," that he is unpractical—is an unfortunate estimate gained from unappreciative observation of workers in pure science, but it no longer holds. Henry, Agassiz, Baird—all men of affairs, now gone—did much to change this popular estimate, and the host of brilliant men who have succeeded them—men of high scientific rank, who control the destinies and shape the policies of great institutions, and who turn out work of great and important practical value—have demonstrated beyond the slightest doubt that scientific men are the broadest men of affairs, that they are practical men, and that they are fit to be leaders, not only in thought, but in action.

It is doubtful whether any Government in existence does as much for the encouragement and development of science as does our own. This has repaid her a thousandfold, and the sound judgment of the American people and their patriotic pride in national attainment will effect a steady increase in governmental support of scientific work in spite of temporary checks. With scientific men, however, must come the initiative. They must point out the needs and the ways and means by which these needs must be supplied.

Dr. B. T. Galloway spoke as follows:—

Is it not true that the attitude of the State toward science and scientific research is at all times greatly influenced by the shaping of public sentiment through the work of scientific men themselves? This is a practical age, and in America especially the tendency is more and more to give a practical trend to almost every line of research. We find, therefore, as a matter of fact, that there is a general lack of interest in, and support of, matters having to do with pure science alone, while on the other hand all questions having practical application, and even those in which the practical end is remote, are received with commendable liberality. Taking the field of botany, for example, it would be difficult, if not impracticable, to secure support for the preparation and publication of purely floristic monographs, unless it could be pretty clearly shown that such a project had some practical end in view.

In so far, therefore, as the attitude of the State towards all work of this nature is concerned, there is a great deal of conservatism to be overcome, and this conservatism is especially pronounced where pure science is brought strongly to the front. The reason for this is not far to seek, for its roots lie imbedded in the selfishness of human nature, which, acting through organisation in the shape of government, sees, or thinks it sees, in the aggressiveness of science a menace to existing institutions in some form or other. While science in its nature is aggressive, the men who do most to advance it often lack aggressiveness, and for this reason the far-reaching effect of science as an educational factor at the present time is not fully understood or appreciated.

This brings me more particularly to the main question I wish to raise in this discussion, namely, what should be the attitude of the scientific man toward the cause he represents. I am strongly of the opinion that he owes it to himself and to his work to put forth every legitimate effort to advance the interests of the cause. He should, of course, keep constantly before him the fact that to bring honour and credit to the work he must recognise the duties of life. This will not allow him, however, to sit calmly down and wait for the material things of the world to come to him. The men who have it in their power to aid him are too busy to go out of their way to render help unless that help is sought. . . .

With the distinctly utilitarian sentiment towards science, as pointed out, the question arises as to what stand should be taken by those charged with the guidance of the work with respect to shaping a general policy which will meet the demand for practical ends, and at the same time advance the cause of science to the fullest extent. Extremes must be avoided, for if the tendency is too strong toward pure science, opportunities will be lost through lack of support, and if toward ultra-utilitarianism, science itself will be endangered through the development of false views, erroneous statements and lack of judgment—rocks and reefs that must by all means be avoided. There is always a medium ground, however, where science and practice can each be made to help the other and each be the stronger for the support thus gained. This is the stand, I may say, that is now taken by those charged with most of the work conducted under the auspices of the Government, and which, during the past fifteen years at least, has resulted in a rapid development of all work along broad and safe lines. Most of the departments of the Government, wherein scientific work is carried on, owe their existence to a demand for greater knowledge on problems concerning the interests and welfare of the people. In the early days of this work too much attention was given to a mere diffusion of knowledge without regard to its source, and as a result of this original research did not receive the attention it deserved. In later years, however, the importance of research is becoming more and more appreciated, and as a result the work has increased in strength and now commands the respect it deserves. . . .

Prof. W. T. Sedgwick referred to the attitude of the people toward scientific investigation, and the hindrance inflicted upon scientific research by the tariff upon the requisite books and instruments. He added:—

I have been very much interested to hear the quotation from the "Message of Washington" urging upon our people the importance of promoting scientific investigation and research. I believe that the American people are, in increasing numbers, large-minded enough to look through and beyond the nearer every-day phenomena, and to realise that the promotion of discovery, no less than the promotion of learning, pays in every sense of the word. They perceive that it pays in the highest sense, in the enrichment of intellect and the cultivation of faculty. They perceive also that it pays in the utilitarian sense, in that it gives leadership among the nations of the earth in the applications of science which always follow hard upon the heels of discovery. Prof. Osborn has done well to point out that those nations which support research most liberally are those which are taking the lead in the industrial world to-day.

The barrier between pure and applied science is fading away, because they are constantly drawing nearer together and overgrowing one another. Pure science has given to applied science the fundamental elements of truth, perfection, knowledge and skill. Applied science, on the other hand, has developed so prodigiously as to react favourably upon pure science, furnishing for it rich sustenance and fertile soil in which it may flourish. An hour might well be spent in pointing out, not only the aid which pure science has given to applied science, but reciprocally the enormous development of pure science and scientific investigation wrought by applied science. It is one of the marvels of the day that many highly organised and differentiated industries, and even many of the coarser arts, find their narrow but sufficient basis of profit in the employment of the results of the latest and most advanced researches in pure science.

Our age has been called by one of the speakers who has preceded me a practical age, and so it is; but it is an age which has discovered in science the Promethean fire. The highest and truest utilitarianism of to-day is a generous cultivation of scientific investigation, not indeed for its own sake, but for the sake of the results which are sure to follow from it. As to the pursuit of science for its own sake, Prof. Osborn has, it seems to me, used a happy illustration in referring to the scientific investigations of the Government as an investment rather than an immediate outlay for current expenses. As to pure science pursued strictly for its own sake, I think we may rather describe it as an investment from which we still expect ultimately some return. Science for its own sake is, after all, much like investment for its own sake; which has never been made, I fancy, even by the least practical of philanthropists.

For illustration of public appreciation of scientific research as a necessity for practical results, I may give an example. When in 1886 the newly organised State Board of Health of Massachusetts attacked scientifically the problem of protection of the purity of inland waters, they reported to the people of that State that in order to do the work required by the Legislature it would be necessary to inaugurate and prosecute special and novel investigations, and for this and other purposes they asked for an appropriation of 30,000 dollars. This sum was immediately and cheerfully granted by the people for this purpose and has ever since been continued, annually, with the result that the Massachusetts experiments are referred to with commendation and advantage by bacteriologists and engineers all over the world. Again, when it became clear that antitoxin for diphtheria had become a public necessity and its proper preparation a public duty, the same State Board of Health secured the services of one of the most distinguished

bacteriologists in the country, Prof. Theobald Smith, and requested him, not only to prepare antitoxin for the citizens of the State, but also to investigate the best methods of its preparation and preservation, besides other cognate and novel but pressing problems in the field of pure science. Here also the most thorough-going utilitarianism has proved to be scientific investigation pushed to its utmost limits. . . .

THE EFFECT OF PHYSICAL AGENTS ON BACTERIAL LIFE.[1]

THE fact that life did not exist upon the earth at a remote period of time, the possibility of its present existence as well as the prospect of its ultimate extinction, can be traced to the operation of certain physical conditions. These physical conditions upon which the maintenance of life as a whole depends are in their main issues beyond the control of man. We can but study, predict and, it may be, utilise their effects for our benefit. Life in its individual manifestations is, therefore, conditioned by the physical environment in which it is placed. Life rests on a physical basis, and the main springs of its energies are derived from a larger world outside itself. If these conditions, physical or chemical, are favourable, the functions of life proceed; if unfavourable, they cease—and death ultimately ensues. These factors have been studied and their effects utilised to conserve health or to prevent disease. It is our purpose this evening to study some of the purely physical factors, not in their direct bearing on man, but in relation to much lower forms in the scale of life—forms which constitute in number a family far exceeding that of the human species, and of which we may produce at will in a test-tube, within a few hours, a population equal to that of London. These lowly forms of life—the bacteria—belong to the vegetable kingdom, and each individual is represented by a simple cell.

These forms of life are ubiquitous in the soil, air and water, and are likewise to be met with in intimate association with plants and animals, whose tissues they may likewise invade with injurious or deadly effects. Their study is commonly termed bacteriology—a term frequently regarded as synonymous with a branch of purely medical investigation. It would be a mistake, however, to suppose that bacteriology is solely concerned with the study of the germs of disease. The dangerous microbes are in a hopeless minority in comparison with the number of those which are continually performing varied and most useful functions in the economy of nature. Their wide importance is due to the fact that they ensure the resolution and redistribution of dead and effete organic matter which, if allowed to accumulate, would speedily render life impossible on the surface of the earth. If medicine ceased to regard the bacteria, their study would still remain of primary importance in relation to many industrial processes in which they play a vital part. It will be seen, therefore, that their biology presents many points of interest to scientific workers generally. Their study as factors that ultimately concern us really began with Pasteur's researches upon fermentation. The subject of this evening's discourse, the effect of physical agents on bacterial life, is important not merely as a purely biological question, though this phase is of considerable interest, but also on account of the facts I have already indicated, viz. that micro-organisms fulfil such an important function in the processes of nature, in industrial operations, and in connection with the health of man and animals. It depends largely on the physical conditions to be met with in nature whether the micro-organisms exercise their functions, and likewise whether they die or remain inactive. Further, the conditions favouring one organism may be fatal to another, or an adaptability may be brought about to unusual conditions for their life. To the technologist the effect of physical agents in this respect is of importance, as a knowledge of their mode of action will guide him to the means to be employed for utilising the micro-organisms to the best advantage in processes of fermentation. The subject is of peculiar interest to those who are engaged in combating disease, as a knowledge of the physical agents that favour or retard bacterial life will furnish indications for the preventive measures to be adopted. With a suitable soil and an adequate temperature the propagation of bacteria proceeds with great rapidity. If the primary conditions of soil and an adequate temperature are not present, the organisms will not multiply; they remain quiescent or they die. The surface layers of the soil harbour the vast majority of the bacteria, and constitute the great storehouse in nature for these forms of life. They lessen in number in the deeper layers of the soil, and few or none are to be met with at a depth of 8–10 feet. As a matter of fact, the soil is a most efficient bacterial filter, and the majority of the bacteria are retained in its surface layers and are to be met with there. In the surface soil, most bacteria find the necessary physical conditions for their growth, and may be said to exist there under natural conditions. It is in the surface soil that their main scavenging functions are performed. In the deeper layers, the absence of air and the temperature conditions prove inimical to most forms.

Amongst pathogenic bacteria the organisms of lockjaw and of malignant œdema appear to be eminently inhabitants of the soil. As an indication of the richness of the surface soil in bacteria I may mention that 1 gramme of surface soil may contain from several hundred thousand to as many as several millions of bacteria. The air is poorest in bacteria. The favouring physical conditions to be met with in the soil are not present in the air. Though bacteria are to be met with in the air they are not multiplying forms, as is the case in the soil. The majority to be met with in air are derived from the soil. Their number lessens when the surface soil is moist, and it increases as the surface soil dries. In a dry season the number of air organisms will tend to increase.

Town air contains more bacteria than country air, whilst they become few and tend to disappear at high levels and on the sea. A shower of rain purifies the air greatly of bacteria. The organisms being, as I stated, mainly derived from the surface of the ground, their number mainly depends on the physical condition of the soil, and this depends on the weather. Bacteria cannot pass independently to the air, they are forcibly transferred to it with dust from various surfaces. The relative bacterial purity of the atmosphere is mainly, therefore, a question of dust. Even when found floating about in the air the bacteria are to be met with in much greater number in the dust that settles on exposed surfaces, *e.g.* floors, carpets, clothes and furniture. Through a process of sedimentation the lower layers of the air become richer in dust and bacteria, and any disturbance of dust will increase the number of bacteria in the air.

The simple act of breathing does not disseminate disease germs from a patient; it requires an act of coughing to carry them into the air with minute particles of moisture. From the earliest times great weight has been laid upon the danger of infection through air-borne contagia, and with the introduction of antiseptic surgery the endeavour was made to lessen this danger as much as possible by means of the carbolic spray, &c. In the same connection numerous bacteriological examinations of air have been made with the view of arriving at results of hygienic value. The average number of micro-organisms present in the air is 500–1000 per 1000 litres; of this number only 100–200 are bacteria, and they are almost entirely harmless forms. The organisms of suppuration have been detected in the air, and the tubercle bacillus in the dust adhering to the walls of rooms. Investigation has not, however, proved air to be one of the important channels of infection. The bactericidal action of sunlight, desiccation, and the diluting action of the atmosphere on noxious substances, will always greatly lessen the risk of direct aërial infection.

The physical agents that promote the passage of bacteria into the air are inimical to their vitality. Thus, the majority pass into the air, not from moist, but from dry surfaces, and the preliminary drying is injurious to a large number of bacteria. It follows that if the air is rendered dust-free, it is practically deprived of all the organisms it may contain. As regards enclosed spaces, the stilling of dust and more especially the disinfection of surfaces liable to breed dust or to harbour bacteria are more important points than air disinfection, and this fact has been recognised in modern surgery. In an investigation, in conjunction with Mr. Lunt, an estimation was arrived at of the ratio existing between the number of dust particles and bacteria in the air. We used Dr. Aitken's Dust-counter, which not only renders the dust particles visible, but gives a means of counting them in a sample of air. In an open suburb of London we found 20,000 dust particles in 1 cubic centimetre of air; in a yard in the centre of London about 500,000. The dust contamination we found to be about 900 per cent. greater in the centre of London than in a quiet suburb. In the open air of

[1] Discourse delivered at the Royal Institution by Dr. Allan Macfadyen, Director of the Jenner Institute of Preventive Medicine.

London there was, on an average, just one organism to every 38,300,000 dust particles present in the air, and in the air of a room, amongst 184,000,000 dust particles, only one organism could be detected.

These figures illustrate forcibly the poverty of the air in microorganisms even when very dusty, and likewise the enormous dilution they undergo in the atmosphere. Their continued existence is rendered difficult through the influence of desiccation and sunlight. Desiccation is one of nature's favourite methods for getting rid of bacteria. Moisture is necessary for their development and their vital processes, and constitutes about 80 per cent. of their cell-substance. When moisture is withdrawn, most bacterial cells, unless they produce resistant forms of the nature of spores, quickly succumb. The organism of cholera air-dried in a thin film dies in three hours. The organisms of diphtheria, typhoid fever and tuberculosis show more resistance, but die in a few weeks or months.

Dust containing tubercle bacilli may be carried about by air currents, and the bacilli in this way transferred from an affected to a healthy individual. It may, however, be said that drying attenuates and kills most of these forms of life in a comparatively short time. The spores of certain bacteria may, on the other hand, live for many years in a dried condition, *e.g.* the spores of anthrax bacilli which are so infective for cattle and also for man (wool-sorter's disease). Fortunately, few pathogenic bacteria possess spores, and, therefore, drying by checking and destroying their life is a physical agent that plays an important *rôle* in the elimination of infectious diseases. This process is aided by the marked bactericidal action of *sunlight*. Sunlight, which has a remarkable fostering influence on higher plant life, does not exercise the same influence on the bacteria. With few exceptions we must grow them in the dark in order to obtain successful cultures; and a sure way of losing our cultures is to leave them exposed to the light of day. Direct sunlight is the most deadly agent, and kills a large number of organisms in the short space of one to two hours; direct sunlight proves fatal to the typhoid bacillus in half an hour to two hours, to the diphtheria bacillus in half an hour to one hour, and to the tubercle bacillus in a few minutes to several hours. Even anthrax spores are killed by direct light in three and a half hours. Diffuse light is also injurious, though its action is slower. By exposing pigment-producing bacteria to sunlight, colourless varieties can be obtained, and virulent bacteria so weakened that they will no longer produce infection. The germicidal action of the sun's rays is most marked at the blue end of the spectrum, at the red end there is little or no germicidal action. It is evident that the continuous daily action of the *sun* along with *desiccation* are important physical agents in arresting the further development of the disease germs that are expelled from the body.

It has been shown that sunlight has an important effect in the spontaneous purification of rivers. It is a well-known fact that a river, despite contamination at a given point, may show little or no evidence of this contamination at a point further down in its course. Buchner added to water 100,000 colon bacilli per cubic centimetre, and found that all were dead after one hour's exposure to sunlight. He also found that in a clear lake the bactericidal action of sunlight extended to a depth of about six feet. Sunlight must therefore be taken into account as an agent in the purification of waters, in addition to sedimentation, oxidation and the action of algæ.

Air or the oxygen it contains has important and opposite effects on the life of bacteria. In 1861 Pasteur described an organism in connection with the butyric acid fermentation which would only grow in the absence of free oxygen. And since then a number of bacteria, showing a like property, have been isolated and described. They are termed anærobic bacteria, as their growth is hindered or stopped in the presence of air. The majority of the bacteria, however, are ærobic organisms, inasmuch as their growth is dependent upon a free supply of oxygen. There is likewise an intermediate group of organisms which show an adaptability to either of these conditions, being able to develop with or without free access to oxygen. Preeminent types of this group are to be met with in the digestive tract of animals, and the majority of disease-producing bacteria belong to this adaptive class. When a pigment-producing organism is grown without free oxygen its pigment production is almost always stopped. For anærobic forms N and H_2 give the best atmosphere for their growth, whilst CO_2 is not favourable and may be positively injurious, as, *e.g.*, in the case of the cholera organism.

The physical conditions favouring the presence and multiplication of bacteria in water under natural conditions are a low altitude, warmth, abundance of organic matter and a sluggish or stagnant condition of the water. As regards water-borne infectious diseases such as typhoid or cholera, their transmission to man by water may be excluded by simple boiling or by an adequate filtration. The freezing of water, whilst stopping the further multiplication of organisms, may conserve the life of disease germs by eliminating the destructive action of commoner competitive forms. Thus the typhoid bacillus may remain frozen in ice for some months without injury. Employment of ordinary cold is not, therefore, a protection against dangerous disease germs.

As regards *electricity*, there is little or no evidence of its direct action on bacterial life, the effects produced appear to be of an indirect character due to the development of heat or to the products of electrolysis.

Ozone is a powerful disinfectant, and its introduction into polluted water has a most marked purifying effect. The positive effects of the electric current may therefore be traced to the action of the chemical products and of heat. I am not aware that any direct action of the X-rays on bacteria has up to the present been definitely proved.

Mechanical agitation, if slight, may favour, and if excessive may hinder bacterial development. Violent shaking or concussion may not necessarily prove fatal so long as no mechanical lesion of the bacteria is brought about. If, however, substances likely to produce triturating effects are introduced, a disintegration and death of the cells follows. Thus Rowland, by a very rapid shaking of tubercle bacilli in a steel tube with quartz sand and hard steel balls, produced their complete disintegration in ten minutes.

Bacteria appear to be very resistant to the action of *pressure*. At 300-450 atmospheres putrefaction still takes place, and at 600 atmospheres the virulence of the anthrax bacillus remained unimpaired. Of the physical agents that affect bacterial life, temperature is the most important. Temperature profoundly influences the activity of bacteria. It may favour or hinder their growth, or it may put an end to their life. If we regard temperature in the first instance as a favouring agent, very striking differences are to be noted. The bacteria show a most remarkable range of temperature under which their growth is possible, extending from zero to 70° C. If we begin at the bottom of the scale we find organisms in water and in soil that are capable of growth and development at zero. Amongst these are certain species of phosphorescent bacteria which continue to emit light even at this low temperature. At the Jenner Institute we have met with organisms growing and developing at 34-40° F. The vast majority of interest to us find, however, the best conditions for their growth from 15° up to 37° C. Each species has a minimum, an optimum and a maximum temperature at which it will develop. It is important in studying any given species that the optimum temperature for their development be ascertained, and that this temperature be maintained. In this respect we can distinguish three broad groups. The first group includes those for which the optimum temperature is from 15-20° C. The second group includes the parasitic forms, viz. those which grow in the living body and for which the optimum temperature is at blood heat, viz. 37° C. We have a third group for which the optimum temperature lies as high as 50-55° C. On this account this latter group has been termed thermophilic, on account of its growth at such abnormally high temperatures—temperatures which are fatal to other forms of life. They have been the subject of personal investigation in conjunction with Dr. Blaxall. We found that there existed in nature an extensive group of such organisms to which the term thermophilic bacteria was applicable. Their growth and development occurred best at temperatures at which ordinary protoplasm becomes inert or dies. The best growths were always obtained at 55-65° C. Their wide distribution was of a striking nature. They were found by us in river water and mud, in sewage, and also in a sample of sea water. They were present in the digestive tract of man and animals, and in the surface and deep layers of the soil as well as in straw and in all samples of ensilage examined. Their rapid growth at high temperatures was remarkable, the whole surface of the culture medium being frequently overrun in from fifteen to seventeeen hours. The organisms examined by us (fourteen forms in all) belonged to the group of the Bacilli. Some were motile, some curdled milk, and some liquefied gelatin in virtue of a proteolytic enzyme.

The majority possessed reducing powers upon nitrates and decomposed proteid matter. In some instances cane sugar was inverted and starch was diastased. These facts well illustrate the full vitality of the organisms at these high temperatures, whilst all the organisms isolated grew best at 55°-65° C. A good growth in a few cases occurred at 72° C. Evidence of growth was obtained even at 74° C. They exhibited a remarkable and unique range of temperature, extending as far as 30° of the Centigrade scale.

As a concluding instance of the activity of these organisms we may cite their action upon cellulose. Cellulose is a substance that is exceedingly difficult to decompose, and is therefore used in the laboratory for filtering purposes in the form of Swedish filter paper, on account of its resistance to the action of solvents. We allowed these organisms to act on cellulose at 60° C. The result was that in ten to fourteen days a complete disintegration of the cellulose had taken place, probably into CO_2 and marsh gas. The exact conditions that may favour their growth, even if it be slow at subthermophilic temperatures, are not yet known —they may possibly be of a chemical nature.

Organisms may be gradually *acclimatised* to temperatures that prove unsuited to them under ordinary conditions. Thus the anthrax bacillus, with an optimum temperature for its development of 37° C., may be made to grow at 12° C. and at 42° C. Such anthrax bacilli proved pathogenic for the frog with a temperature of 12° C., and for the pigeon with a temperature of 42° C.

Let us in a very few words consider the inimical action of temperature on bacterial life. An organism placed below its minimum temperature ceases to develop, and if grown above its optimum temperature becomes attenuated as regards its virulence, etc., and may eventually die. The boiling point is fatal for non sporing organisms in a few minutes. The exact thermal death-point varies according to the optimum and maximum temperature for the growth of the organism in question. Thus for water bacteria with a low optimum temperature blood heat may be fatal; for pathogenic bacteria developing best at blood heat, a thermophilic temperature may be fatal (60° C.); and for thermophilic bacilli any temperature above 75° C. These remarks apply to the bacteria during their multiplying and vegetating phase of life. In their resting or spore stage the organisms are much more resistant to heat. Thus the anthrax organism in its bacillary phase is killed in one minute at 70° C.; in its spore stage it resists this temperature for hours, and is only killed after some minutes by boiling. In the soil there are spores of bacteria which require boiling for sixteen hours to ensure their death. These are important points to be remembered in sterilisation or disinfection experiments, viz. whether an organism does or does not produce these resistant spores. Most non-sporing forms are killed at 60° C. in a few minutes, but in an air-dry condition a longer time is necessary. Dry heat requires a longer time to act than moist heat: is requires 140° C. for three hours to kill anthrax spores. Dry heat cannot, therefore, be used for ordinary disinfection on account of its destructive action. Moist heat in the form of steam is the most effectual disinfectant, killing anthrax spores at boiling point in a few minutes, whilst a still quicker action is obtained if saturated steam under pressure be used. No spore, however resistant, remains alive after one minute's exposure to steam at 140° C. The varying thermal death-point of organisms and the problems of sterilisation cannot be better illustrated than in the case of milk, which is an admirable soil for the growth of a large number of bacteria. The most obvious example of this is the souring and curdling of milk that occurs after it has been standing for some time. This change is mainly due to the lactic acid bacteria, which ferment the milk sugar with the production of acidity.

Another class of bacteria may curdle the milk without souring it in virtue of a rennet-like ferment, whilst a third class precipitate and dissolve the casein of the milk, along with the development of butyric acid. The process whereby milk is submitted to a heat of 65° to 70° C. for twenty minutes is known as pasteurisation, and the milk so treated is familiar to us all as pasteurised milk. Whilst the pasteurising process weeds out the lactic acid bacteria from the milk, a temperature of 100° C. for one hour is necessary to destroy the butyric acid organisms: and even when this has been accomplished there still remain in the milk the spores of organisms which are only killed after a temperature of 100° C. for three to six hours. It will, therefore, be seen that pasteurisation produces a partial, not a complete sterilisation of the milk as regards its usual bacterial inhabitants. The sterilisation to be absolute would require six hours at boiling point. But for all ordinary practical purposes pasteurisation is an adequate procedure. All practical hygienic requirements are likewise adequately met by pasteurisation, if it is properly carried out and the milk is subsequently cooled. Milk may carry the infection of diphtheria, cholera, typhoid and scarlet fevers as well as the tubercle bacillus from a diseased animal to the human subject. For the purpose of rendering the milk innocuous, freezing and the addition of preservatives are inadequate methods of procedure. The one efficient and trustworthy agent we possess is heat. Heat and cold are the agents to be jointly employed in the process, viz a temperature sufficiently high to be fatal to organisms producing a rapid decomposition of milk, as well as to those which produce disease in man; this to be followed by a rapid cooling to preserve the fresh flavour and to prevent an increase of the bacteria that still remain alive. The pasteurising process fulfils these requirements.

In conjunction with Dr. Hewlett, I had occasion to investigate in how far the best pasteurising results might be obtained. We found that 60° to 68° C. applied for twenty minutes weeded out about 90 per cent. of the organisms present in the milk, leaving a 10 per cent. residue of resistant forms. It was found advisable to fix the pasteurising temperature at 68° C. in order to make certain of killing any pathogenic organisms that may happen to be present. We passed milk in a thin stream through a coil of metal piping, which was heated on its outer surface by water. By regulating the length of the coil, or the size of the tubing, or the rate of flow of the milk, almost any desired temperature could be obtained. The temperature we ultimately fixed at 70° C. The cooling was carried out in similar coils placed in iced water. The thin stream of milk was quickly heated and quickly cooled as it passed through the heated and cooled tubing, and, whilst it retained its natural flavour, the apparatus accomplished at 70° C. in thirty seconds a complete pasteurisation, instead of in twenty minutes, *i.e.* about 90 per cent. of the bacteria were killed, whilst the diphtheria, typhoid, tubercle and pus organisms were destroyed in the same remarkably short period of time, viz. thirty seconds. This will serve to illustrate how the physical agent of heat may be employed, as well as the sensitiveness of bacteria to heat when it is adequately employed.

Bacteria are much more sensitive to high than to low temperatures, and it is possible to proceed much further downwards than upwards in the scale of temperature, without impairing their vitality. Some will even multiply at zero, whilst others will remain alive when frozen under ordinary conditions.

I will conclude this discourse by briefly referring to experiments recently made with the most remarkable results upon the influence of low temperatures on bacterial life. The experiments were conducted at the suggestion of Sir James Crichton-Browne and Prof. Dewar. The necessary facilities were most kindly given at the Royal Institution, and the experiments were conducted under the personal supervision of Prof. Dewar. The action of liquid air on bacteria was first tested. A typical series of bacteria was employed for this purpose, possessing varying degrees of resistance to external agents. The bacteria were first simultaneously exposed to the temperature of liquid air for twenty hours (about − 190° C.). In no instance could any impairment of the vitality of the organisms be detected as regards their growth or functional activities. This was strikingly illustrated in the case of the phosphorescent organisms tested. The cells emit light which is apparently produced by a chemical process of intracellular oxidation, and the phenomenon ceases with the cessation of their activity. These organisms, therefore, furnished a very happy test of the influence of low temperatures on vital phenomena. These organisms when cooled down in liquid air became non-luminous, but on re-thawing the luminosity returned with unimpaired vigour as the cells renewed their activity. The sudden cessation and rapid renewal of the luminous properties of the cells despite the extreme changes of temperature was remarkable and striking. In further experiments the organisms were subjected to the temperature of liquid air for seven days. The results were again *nil*. On re-thawing the organisms renewed their life processes with unimpaired vigour. We had not yet succeeded in reaching the limits of vitality. Prof. Dewar kindly afforded the opportunity of submitting the organisms to the temperature of liquid hydrogen—about − 250° C. The same series of organisms was employed, and again the result was *nil*. This temperature is only 21° above that of the absolute zero, a

temperature at which, on our present theoretical conceptions, molecular movement ceases and the entire range of chemical and physical activities with which we are acquainted either cease or, it may be, assume an entirely new *rôle*. This temperature, again, is far below that at which any chemical reaction is known to take place. The fact, then, that life can continue to exist under such conditions affords new ground for reflection as to whether, after all, life is dependent for its continuance on chemical reactions. We, as biologists, therefore follow with the keenest interest Prof. Dewar's heroic attempts to reach the absolute zero of temperature; meanwhile his success has already led us to reconsider many of the main issues of the problem. And by having afforded us a new realm in which to experiment, Prof. Dewar has placed in our hands an agent of investigation from the effective use of which we who are working at the subject at least hope to gain a little further insight into the great mystery of life itself.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The election to the vacancy on the Council of the Senate, caused by the resignation of Bishop Ryle, will take place on February 8.

Mr. Stanley Gardiner has presented to the University an ethnological collection of 300 objects from the Maldives and Minikoi. The collection contains many valuable specimens.

Mr. W. N. Shaw, F.R.S., Secretary to the Meteorological Council, will give in the Cavendish laboratory a course of four lectures on the Physics of the Atmosphere, at 4.30, on February 7, 14, 21, and 28.

The Special Board for Biology recommend that the annual grant of 100*l.* shall be made by the University to Dr. Dohrn's Zoological Station at Naples for a further period of five years.

The Senate has sanctioned the obtaining of specifications and tenders for the erection of the Humphry Museum as a portion of the new Medical School Buildings.

THE following appointments have recently been made at the Jenner Institute of Preventive Medicine:—Dr. S. G. Hedin, of the University of Lund, Sweden, has been appointed head of the department of pathological chemistry; Mr. J. Beresford Leathes, lecturer in physiology at St. Thomas's Hospital Medical School, assistant in the same department; and Mr. W. J. Young, of the Owens College, Manchester, assistant in the chemical department. Drs. Moore, Petrie and Mackenzie have been elected to fill the three research studentships, the last-named gentleman being appointed to the Grocers' Company research studentship of the Jenner Institute.

AT the meeting of the London County Council on Monday, the Chairman announced that a letter had been received from Mr. Horniman, a member of the Council, offering on behalf of his father, Mr. Horniman, M.P., to the people of London a gift of great value, probably representing from 50,000*l.* to 100,000*l.* The letter was as follows:—"Dear Mr. Dickinson,—I have been empowered by my father, Mr. Horniman, M.P., who is now travelling in the East, to offer as a free gift to the people of London some fifteen acres of freehold land, together with the museum which has just been erected at the cost of about 40,000*l.* In it are placed the large art and natural history collections gathered by Mr. Horniman during the last twenty-five years. The property is situated close to Lordship Lane Station on the South Eastern and Chatham Railway and about three-quarters of a mile from Forest Hill Station on the London, Brighton and South Coast Railway. It consists of:—(1) A large house known as Surrey Mount and some nine and a half acres of pleasure grounds on the summit and slope of a hill commanding extensive views over south-eastern and south-western London. The site is a suitable one for a park or recreation ground, and has been open to the public during the summer months for four years. Over 200,000 persons visited it during fourteen months in 1897 and 1898. (2) The museum, a stone building 258 ft. long by 61 ft. wide, with a superficial area of 16,485 square feet. (3) Six residences, occupying some $5\frac{1}{2}$ acres of ground, now let on leases of diverse terms and bringing in an income of about 600*l.* per annum, which could be used for the maintenance of the museum until the tenancies fall in, when the land could be added to the recreation ground and additions made to the museum if necessary. There is also a library of 5,500 volumes of travel, natural history, &c., and a Biblical library of 700 volumes, containing many early and rare editions. Notwithstanding the very inadequate way in which the collections were formerly housed, and the fact that they were open to the public on but two or three days a week, over 455,000 persons visited them in four years, averaging 660 per day in the last year. Mr. Horniman considers the time has now arrived when the museum and adjoining property will be more useful if vested in a public body, and he has much pleasure in offering the same to the London County Council as a place of public recreation and instruction. Beyond a condition that the museum and grounds are to be maintained in a proper condition and dedicated to the public for ever there are few or no conditions attached to the proposed gift, and I am sure there are none that the Council could not readily accept.—Yours faithfully, Emslie John Horniman." It was resolved that the offer be accepted, and that the thanks of the Council be conveyed to Mr. Horniman for his munificent gift.

SCIENTIFIC SERIAL.

Wiedemann's Annalen der Physik, January.—Double refraction in glass plates vibrating transversely, by W. Konig. In a long glass plate or rod vibrating transversely, there is at the nodes double refraction of a peculiar kind. This has been subjected to a detailed experimental study, and the results discussed fully from the theoretical point of view. The author has been successful in obtaining photographic records of these phenomena, copies of which accompany the paper.—On the tones produced by vibrating sheets of gas in flames, by V. Henson. A photographic study of vibrating flames.—On the absorption of light in coloured glass, by R. Zgismondy. The colour of a glass, and hence its absorption spectrum, depends, not only upon the nature of the colouring material present, but also upon the composition of the colourless glass itself. Experiments were therefore carried out with twelve glasses of different composition, varying from pure sodium and potassium silicate on the one hand to pure lead silicate on the other. Borax and fused boron trioxide were also examined. The colouring oxides included the oxides of copper, chromium, cobalt, nickel, manganese, iron and uranium. For these glasses the constant $A = E/gS$ was determined, where S is the specific gravity of the glass, g the number of milligrams of the colouring oxide per gram of glass, and E the extinction coefficient. The results are expressed graphically.—On the decrement of the electrical vibrations on the charging of condensers, by A. F. Sundell and Hj. Tallqvist. Although in many researches on damped vibrations the experimental figures for the time of oscillation agree well with those deduced theoretically, in the case of the decrement of these vibrations the agreement is either very rough, or there is no agreement at all. In the present series of experiments it is shown that if the necessary corrections are introduced, the experimental and theoretical results agree exactly.—On the melting point of gold, by L. Holborn and A. Day (see p. 330).—On the expansion of some metals at high temperatures, by L. Holborn and A. Day. The coefficients of expansion of platinum, palladium, silver, 20 per cent. platinum-iridium nickel, constantin, wrought iron and steel were determined for temperatures between 0° and 1000° C., where the melting-points allowed.—On the irregularity of the Weston cadmium element with 14·3 per cent. amalgam in the neighbourhood of 0° C., by W. Jaeger. It is shown that in the neighbourhood of 0° C. the irregular variations of this cell may amount to as much as two millivolts, although at 10° C. different elements agree to within a few tenths of a millivolt.—Communication to the knowledge of the phenomena in induction apparatus, by K. K. Johnson.—On surface tension, by H. Hulshof. The necessary existence of surface tension is deduced from the assumption of a continuous density variation in the capillary layer.—On the numerical relation between the two elasticity constants in isotropic media, according to the molecular theory, by W. Voigt.—On the electrical analogue to the Zeeman effect, by W. Voigt.—On the change of the form of vibration of light when propagated through a dispersive and absorbing medium, by W. Voigt.—Calculation of the conductivity of gases, by J. Stark.—A criticism of the mode of derivation of Wien's spectrum equation, by E. Jahnke, O. Lummer and E. Pringsheim.—On the history of telegraphy, by L. Lewin.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 17.—"The Thermo-chemistry of the Alloys of Copper and Zinc," by T. J. Baker, King Edward's School, Birmingham. Communicated by Prof. Poynting, F.R.S.

The heats of formation of a number of alloys of copper and zinc have been ascertained by measuring the difference between the heats of dissolution, in suitable solvents, of each alloy and of an equal weight of a mere mixture containing the metals in the same proportion.

The following solvents were employed :—

(*a*) An aqueous solution of chlorine.

(*b*) A mixture of ammonium chloride and ferric chloride solutions.

(*c*) A mixture of ammonium chloride and cupric chloride solutions.

The first solvent did not give satisfactory results, although it showed that the heat of dissolution of an alloy was sensibly less than that of the corresponding mixture.

Solvents *b* and *c* were found to be very suitable; the chemical actions concerned are simple reductions, and no gases are evolved.

Two series of experiments made on twenty-one alloys yielded very concordant results.

A sharply defined maximum heat of formation is found in the alloy containing 32 per cent. of copper, *i.e.* corresponding to $CuZn_2$. It amounts to 52·5 calories per gramme of alloy, or 10,143 calories per gramme-molecule. There is some evidence of a sub-maximum in the alloy corresponding to CuZn.

From these points there is a steady decrease in the heat of formation, both in the case of alloys containing less than 32 per cent. of copper as the quantity of copper decreases, and also in the case of those containing more than 50 per cent. of copper as the amount of copper increases.

The results, in general, confirm the existence of intermetallic compounds, and the values obtained are in accordance with those demanded by Lord Kelvin's calculation of the molecular dimensions of copper and zinc.

Royal Microscopical Society, January 16.—Annual Meeting. William Carruthers, Esq., F.R.S., President, in the chair.—Mr. Hugh M. Leake exhibited a new form of rocking microtome, designed to cut perfectly flat sections. Dr. Hebb said it seemed to remedy the defects of the ordinary Cambridge rocker, it appeared to be easily manipulated and was very stable and solid in construction.—Dr. Hebb read the report of the council for the year 1900.—The president announced that the whole of the Fellows nominated for officers and council had been duly elected, and expressed his thanks to the Fellows of the Society for again placing him in the position which he had occupied during the past year. He congratulated the Society upon the improved conditions indicated in the report. He then read the annual address, which consisted chiefly of an epitome of the life and work of John Ellis, known in his time as "Coralline Ellis."

Mineralogical Society, January 22.—Prof. A. H. Church, F.R.S., President, in the chair.—Dr. C. O. Trechmann contributed a note on an occurrence of colourless, water-clear mirabilite in gypsum-rock from Kirkby Thore in Westmoreland.—Mr. Alfred Harker discussed a question relative to extinction-angles in rock-slices. A rhombic crystal gives straight extinction in any section parallel to a bisectrix. The author has investigated the degree of departure from straight extinction introduced by a slight obliquity in the direction of section, and finds that no serious error can result unless the angle between the optic axes (measured over the bisectrix in question) is a very large one.—Prof. Lewis communicated an additional note by Mr. R. W. H. T. Hudson on the rotation of points and planes about an axis. Mr. W. Barlow exhibited a model showing an arrangement for the chemical atoms of calcite, which gives the observed crystal-symmetry and is capable of artificial twinning. He explained that the indiarubber balls forming the model are intended to show spherical spheres of influence of the atoms, and that he had arrived at the relative magnitudes which should be used by a geometrical study of elementary stereochemical properties of the carbon compounds. Such models are not supposed to throw any light on the actual forms of the chemical atoms, but are consistent with the supposition that each of these is in motion about a geometrical centre, provided that the centre retain a definite relative situation with respect to the centres belonging to other surrounding atoms. In this, like the stereochemists, he lays stress on the space arrangement of the atoms within the molecule. Mr. H. B. Hartley exhibited a device to facilitate the separation of minerals by means of heavy liquids.

PARIS.

Academy of Sciences, January 28.—M. Fouqué in the chair.—The production of hydrogen in the igneous rocks, by M. Armand Gautier. In seeking for the cause of the development of free hydrogen from granitic rocks at a red heat, it was found that hydrogen is evolved when steam is passed over red-hot ferrous salts. The reaction with ferrous sulphide was carefully studied, and found to be in accordance with the equation $3FeS + 4H_2O = Fe_3O_4 + 3H_2S + H_2$. Various rocks, after a preliminary extraction of the occluded gases by heating in a vacuum, gave, on further heating in a current of steam, a mixture of hydrogen, methane and carbon-monoxide.—The expenditure of energy necessitated by motor work and resisting work in man when raising or lowering himself on Hirn's wheel. The evaluation from the oxygen absorbed in the respiratory exchanges, by M. A. Chauveau.—The permanent secretary announced to the Academy the loss it had sustained by the death of M. J. G. Agardh, correspondant in the Section of Botany.—Diverse positions of the neutral fibre in bodies broken by flexure; the cause of fragility, by M. Ch. Frémont. In discussing the experiments of Mr. Hadfield on the mechanical properties of the iron-nickel alloys, it is shown that these results are in accordance with the views previously put forward by the author.—On the propagation of the Hertzian waves in wireless telegraphy, by M. E. Lagrange. From some experiments described, in which the wire emitting the waves was entirely underground, it is concluded that the waves do not penetrate the interior of the earth, and that there is probably absorption and reflection of the waves emitted in the ordinary way.—A study of uranium nitrate, by M. Œchsner de Coninck.—Action of boron bromide upon the iodides of phosphorus and upon the halogen compounds of arsenic and antimony, by M. Tarible. The halogen compounds of phosphorus form double compounds with one or two molecules of boron bromide. The chlorides of arsenic and antimony give an ordinary double decomposition, the bromides and iodides, on the other hand, simply going into solution without any reaction taking place.—Action of œnanthylic alcohol upon its sodium derivative; a new method of synthesis for the alcohols, by M. Marcel Guerbet. As a result of the action of œnanthylic alcohol upon its sodium derivative there is produced œnanthylic acid, di-œnanthylic alcohol, triœnanthylic alcohol, and the corresponding acid.—Direct hydrogenation in presence of reduced nickel; the preparation of hexahydrobenzene, by MM. Paul Sabatier and J. B. Senderens (see p. 354).—On the mechanism of diastatic actions, by M. Hanriot. Further experiments are brought forward in support of the hypothesis that the action of lipase is a reversible one, and it is pointed out that this reversibility is not an isolated fact, a similar action having been already indicated by Hill in the reaction of maltose and glucose. These results modify the views now held as to the function of the internal ferments in the organism.—Researches on fibrinolysis, by M. L. Camus. Immunity can be produced by injecting into the vessels substances in suspension in a 0·8 per cent. solution of salt. Injections of fibrin do not determine the production of a fibrinolytic serum, and the normal serum may dissolve the precipitate caused by the serum of an immunised animal.—On the relations of the Gregarians and the intestinal epithelium, by M. Michel Siedlecki. *Monocystis ascidiae* passes the greatest portion of its period of growth altogether in a cell of the intestinal epithelium of a Tunicate, *Ciona intestinalis*, even in its earliest stages, the Gregarian has the characters of the adult animal, simply increasing in size as its grows.—Intracellular parasitism and the asexual multiplication of the Gregarians, by MM. Maurice Caullery and Félix Mesnil. It is shown that there is a great variety of relations between these parasites and the intestinal epithelium, there being all degrees of development from a growth entirely extracellular to a completely intracellular development. — On the inversion of the heart in one of the component subjects of a living double monster, by M. Chapot-Prévost. One of the subjects, who died shortly after the separating operation, had the heart normally placed. The other, who survived the operation, was shown by radiography to have the heart inverted. This case of cardiac heterotaxy entirely confirms the ideas of Dareste on the

importance of this phenomenon in teratology.—Remarks by M. Lannelongue on the preceding paper.—On the manna of the olive, by M. Trabut. In the region of Bibans there is a considerable number of olive trees which exude during the summer a very large quantity of manna. On analysis this was found to be identical with the manna from the ash, containing about 52 per cent. of mannite.—Influence of the osmotic pressure of the medium on the form and the structure of vegetables, by M. J. Beauverie. The roots of *Phaseolus*, growing in a concentrated solution, possess no medulla, the differentiation of the ligneous tissue proceeding from the centre. There is also very early produced an abundant pericyclic cork layer, having evidently a protective function as regards the central cylinder. In a root of the same age growing in water there is, on the contrary, a voluminous medulla, and there is no premature production of cork.—On the presence of the genus *Caprina* in the Urgonian, by M. V. Paquier.—On the specific heats of silk, wool and cotton, by M. Testenoire. A reclamation of priority against M. G. Fleury.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part 3, for 1900, contains the following memoirs communicated to the Society :—

June 16.—O. Wallach : I. (1) On the splitting-up of cyclic oximes, (2) hexacyclic ketones, (3) heptacyclic ketones ; II. New syntheses in the terpene series.

June 30 —A. Loewy : On the transformation into itself of a non-vanishing Hermite determinant.

July 14.—E. Riecke : On the relative conductivities of metals for heat and for electricity.—D. Hilbert : Mathematical problems, an address before the International Congress of Mathematicians at Paris, 1900.—R. Fricke : Automorphous elementary forms.

July 28.—R. Fricke : Ritter's prime-form on an arbitrary Riemann surface.—A. Voss : On the principles of Hamilton and of Maupertuis.—W. Nernst and H. Reynolds : On the conductivity of solid mixtures at high temperatures.

October 27.—W. Voigt : On the inductivity of ferromagnetic crystals, with special reference to Weiss's observations on magnetite.—M. Dehn : On equivalent polyhedra (capable of dissection into congruent portions).

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 7.

ROYAL SOCIETY, at 4.30.—The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers : Prof. Dewar, F.R.S.—On the Brightness of the Corona of January 22, 1898. Preliminary Note : Prof. H. H. Turner, F.R.S.—Preliminary Determination of the Wave-Lengths of the Hydrogen Lines derived from Photographs taken at Ovar at the Eclipse of the Sun, 1900, May 28 : F. W. Dyson.—Investigations on the Abnormal Outgrowths or Intumescences on *Hibiscus vitifolius*, Linn.: a Study in Experimental Plant Pathology : Miss E Dale.—On the Proteid Reaction of Adamkiewicz, with Contributions to the Chemistry of Glyoxylic Acid : F. G. Hopkins and S. W. Cole.—The Integration of the Equations of Propagation of Electric Waves : Prof. Love, F.R.S.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows —The Action of Hydrogen Bromide on Carbohydrates : H. J. H. Fenton and Mildred Gostling.—Note on a Method of comparing the Affinity-Values of Acids : H. J. H. Fenton and H. O. Jones.—Organic Derivatives of Phosphoryl Chloride, and the Space Configuration of the Valencies of Phosphorus : R. M. Caven.—(1) Synthetical Work with Sodamide Derivatives ; (2) Note on Two Molecular Compounds of Acetamide ; (3) Diacetamide, a New Method of Preparation : Dr. A. W. Titherley.

RÖNTGEN SOCIETY, at 8.—Experiences of X-Ray Work during the Siege of Ladysmith ; Lieut. F. Bruce.

FRIDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 9.—History and Progress of Aërial Locomotion : Prof. G. H. Bryan, F.R.S.

PHYSICAL SOCIETY, at 5. Annual General Meeting.—Address by the President.—Followed by a paper on Mica Echelon Grating : Prof. R. W. Wood.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual General Meeting.

GEOLOGISTS' ASSOCIATION, at 8.—Annual General Meeting.—Twelve Years of London Geology : The President, W. Whitaker, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Cycle Resistance : H. E. Wimperis.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Power-Gas and Large Gas-Engines for Central Stations : H. A. Humphrey.

ANATOMICAL SOCIETY, at 4 30.—The Origin of the Vertebrate Ear and Eighth Pair of Cranial Nerves : W. H. Gaskell, F.R.S.—A Critical Review of Recent Literature on Fossil Anthropoids : W. L. H. Duckworth.

MALACOLOGICAL SOCIETY, at 8.—Annual General Meeting.

MONDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—Origin of Vertebrate Animals : Dr. A. Willey.

SOCIETY OF ARTS, at 8.—The Bearings of Geometry on the Chemistry of Fermentation : W. J. Pope.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—On Her Majesty's Connection with the Society and Interest in Geography, and on Polar Exploration during the Queen's Reign The President —Progress of Exploration and the Spread and Consolidation of the Empire in America, Australasia, and Africa : Right Hon. Sir George Taubman Goldie, K.C.M.G. —Advances in Asia, and Imperial Consolidation in India : Colonel Sir Thomas H. Holdich, K C.I.E.

TUESDAY, FEBRUARY 12.

ROYAL INSTITUTION, at 3.—Practical Mechanics : Prof. J. A. Ewing, F.R.S.

SOCIETY OF ARTS, at 8.—Recent Advances in Pottery Decoration : William Burton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed* : The Present Condition and Prospects of the Panama Canal Works : J. T. Ford.——*Paper to be read, time permitting* : The Nilgiri Mountain-Railway : W. J. Weightman.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Annual General Meeting.

WEDNESDAY, FEBRUARY 13.

SOCIETY OF ARTS, at 8.—Arsenic in Beer and Food : William Thomson.

THURSDAY, FEBRUARY 14.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 5.30.—The Distribution of Velocity and the Equations of the Stream Lines, due to the Motion of an Ellipsoid in Fluid Frictionless and Viscous : T. Stuart —On Factorisable Twin Binomials : Lieut.-Colonel Cunningham, R.E.—Concerning the Abelian and Related Linear Groups : Prof. L. E. Dickson.—A Geometrical Theory of Differential Equations of the First and Second Orders : R. W. Hudson.—Brocardal Properties of some Associated Triangles : R. Tucker.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Greek Retreat from India : Colonel Sir Thomas H. Holdich, K.C.I.E.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Capacity in Alternate Current Working : W. M. Mordey. (Adjourned Discussion.)

FRIDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 9.—Electric Waves : Right Rev. Monsignor Gerald Molloy.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

CONTENTS.

THURSDAY, FEBRUARY 14, 1901.

DARWINISM AND LAMARCKISM, OLD AND NEW.

Four Lectures by Frederick Wollaston Hutton, F.R.S., &c. Pp. x + 171. (London: Duckworth and Co., 1899.)

THE first of the lectures printed in this volume is entitled "Darwinism," and it was delivered at the Philosophical Institute of Canterbury, New Zealand, in 1887; the second, delivered in 1898 to the same Institute, is upon "The New Darwinism"; the third, "Darwinism in Human Affairs," was given in 1882 to the students of Canterbury College, University of New Zealand; while the fourth and concluding lecture, "The New Lamarckism," has been added to render the "treatment of the subject more complete."

The author's object has been to make a clear statement of his subject, suitable for readers who are not specialists and "have no time to study more elaborate works." Throughout a large part of the work he has succeeded in this attempt, although there are passages the meaning of which is not carried on the surface. Thus, at the beginning of the Introduction, a quotation from Darwin is concluded with the words, "This, which was published in 1859, is strictly correct at the present day"; while the next sentence, opening the succeeding paragraph, reads, "In 1899 things are different." By reading on, and then turning back to the preceding page, the apparent confusion is removed, but this is hardly the way to make things easy. Similarly, on p. 9, the word "transmitted" is used in a context which seems to imply heredity, and when the conclusion has been assimilated, the next sentence informs us that the word is not used exclusively in this sense.

The author considers that the increased prominence given to isolation "is the only real advance that has been made since Darwin's death" (p. 5); but surely the question of the hereditary transmission of acquired characters is in a totally different position to-day from what it was in 1882; and the change as regards this subject from the old uncritical, somewhat slipshod attitude of the past must be counted as a very real advance. Although Lamarck receives generous treatment in the book, Buffon is altogether neglected, his suggested causes of change in the direct influence of the environment being set down to the later zoologist.

Romanes' term, "physiological selection," is criticised because, "except in the bacteria, species are not founded on physiological characters." The suggested cause of evolution is more than doubtful, but the phrase is certainly a descriptive and appropriate one to express the idea that physiological incompatibility between the germ-cells of certain individuals and those of the rest of the species may be an agency which determines the splitting of a single species into two. The suggested substitution of the phrase "progressive infertility" (p. 12) by no means expresses Romanes' idea; for he conceived of the infertility arising, ready-made and complete, as the result of spontaneous variation. When the author states that species are not founded on physiological characters he forgets (although he himself recognises it elsewhere) that the physiological characters of fertility *inter se* and of infertility with other species have been very widely looked upon as among the most important attributes of a species. Thus Huxley's criticism of the evidence for the acceptance of natural selection may be summed up in the words of his letter to Charles Kingsley:

". . . if Carrier and Tumbler *e.g.* were physiological species equivalent to Horse and Ass, their progeny ought to be sterile or semi-sterile. So far as experience has gone, on the contrary, it is perfectly fertile. . . It has been obvious to me that this is the weak point of Darwin's doctrine. He *has* shown that selective breeding is a *vera causa* for morphological species; he has not shown it a *vera causa* for physiological species." ("Life and Letters," 1900, vol. i. p. 239.)

This quotation is introduced merely to show that there is good warrant for Romanes' use of the term "physiological" in this connection, not because the present writer believes that the suggested difficulty is insuperable.

One of the reasons given for the inference "that the object of physiological evolution was the development of man" seems to be very far-fetched, viz. the existence of a number of elements

"in the world which appear to be of no use except to man: for example, gold, silver, lead, zinc, &c. . . . Not only were these made for man, but they appear to have been made as rewards for the exercise of his intellect. There are other substances, such as the rarer elements, of which no use seems ever likely to be made except the important one of stimulating enquiry" (p. 19).

A similar conviction as to the meaning of the beauty and variety of organic forms is expressed on p. 107.

In the first lecture, "Darwinism," the interesting history of the author's personal experience of evolution is recorded. He had read the "Origin" on its first appearance with avidity, and could detect no flaw in it, but thought that this must be due to his own ignorance. He was soon afterwards convinced by Sir Andrew Ramsay, with whom he went on a geological excursion to the Isle of Wight. In 1861 he wrote an article on the "Origin" in the *Geologist*, and received an extremely kind and interesting letter from Darwin (p. 34).

In criticising Darwin's statement that he owed the idea of natural selection to Malthus, a very interesting passage from the "Journal of a Naturalist" is quoted, apparently proving that the fundamental ideas about natural "checks" and "constant food supply" were clearly fixed in his mind at a very early period (pp. 40–41). The reference is not given, but the important passage should be compared in the different editions of the "Journal."

The statement that Darwin abandoned his hypothesis of pangenesis, "or thought lightly of it" (p. 51), is erroneous. The great "Life and Letters" shows clearly enough that he retained considerable confidence in it even when friends whose opinion he valued very highly did not agree with him. The chief experimental difficulties which oppose it are not alluded to (pp. 59–60), viz. the fact that mutilations, even when continued for a long series of generations, are not inherited, and that transfusion of blood and transplantation of tissue do not produce any hereditary influence.

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The second lecture, "The New Darwinism," contains at the outset (p. 63) an entirely new and erroneous definition of the term "Neo-Darwinian." "The Neo-Darwinians, as we are sometimes called, accept Darwin's teaching, and supplement the theory of natural selection with *methods of isolation*" (italics the author's). As is well known, the term was really applied to those who accepted only that part of Darwin's teachings which was originated by him, and excluded that small but distinct element of Lamarckian doctrine which he incorporated with his own. The history of the use of this term and "Neo-Lamarckian" is as follows. A school of Lamarckian evolutionists grew up in the United States, and reached its maximum about the time that the question of the hereditary transmission of acquired characters became acute, viz., 1887 and the following years. It consisted of Cope, Hyatt, Ryder and several other naturalists; W. B. Scott and H. F. Osborn belonged to it in those days. The members of the school chiefly looked at evolution from the point of view of palæontology. They called themselves Neo-Lamarckians, because they rejected Lamarck's more extravagant suggestions, but believed that in the remainder they had found a satisfactory basis for evolution. When, owing to Weismann's writings, the scope of heredity began to be rigidly investigated, many naturalists quickly recognised that grave doubt was thrown upon the whole of Buffon's and Lamarck's suggestions as to the causes of evolution, and they took their stand on natural selection alone among all hypotheses as yet proposed. In this they followed Weismann and Wallace, and they were called by those who did not agree with them "Weismannians" or "Neo-Darwinians," the term "Darwinian" being reserved for those who believed the whole of Darwin's teaching—the extrinsic element as well as that peculiar to him. This at any rate, was the attempted achievement of the labellers. The naturalists in question had never selected the label which it was sought to affix to them, nor were they pleased with it, as were the Neo-Lamarckians with their invention. They, or at any rate many of them, protested against the term "Darwinism" being used necessarily to include an element extraneous to Darwin, although accepted by him, of very doubtful validity, and liable, if entirely abandoned, to drag down with it the historic title derived from the name of the great English naturalist. "Darwinism," applied, as Wallace applies it, to the hypothesis which was originated by Darwin, is liable to no such objection, and these naturalists maintained that it is in every way appropriate to thus describe natural selection, the one and only suggested cause of evolution which seemed to them to possess any significance or value. The history of the whole controversy is to be found in letters and articles printed in this journal for several years following 1887.

In this second lecture many examples are given of what are believed to be useless specific characters (p. 69–73). The exigencies of space prevent any detailed criticism, but it may be generally stated that many of the cases cited are extremely unconvincing. The question of incipient variations is briefly alluded to without any reference to Dohrn's principle of "change of function," which offers so probable an explanation of many difficulties.

One of the best features of the book is the use made of the natural history of New Zealand and the southern seas (as on pp. 87, 90, 91, &c.).

In the third lecture, "Darwinism in Human Affairs," there is a clear statement of the way in which selection acts on a group of competing individuals distinguished by variation (pp. 110, 111). The concluding sentence of the lecture, on p. 133, is distinctly out of place in a work of this kind. Those who have written on the relations of religious thought and doctrine to the teachings of science have always been welcomed by a large body of readers. But it is unwise, and, fortunately, rare, for the two sets of ideas to be jumbled together haphazard, so that in a professedly scientific work we are suddenly brought up with a shock by some short sentence expressing a religious conviction. The object which the author probably has in view is not advanced by such a method.

The concluding lecture, on "The New Lamarckism," contains much cautious and interesting reasoning upon various instances which are believed to prove the existence of the Lamarckian factors of evolution; although the part which the nervous system probably plays in many of the changes, such as those of pupæ (p. 141) and of mammalian hair (p. 142), is neglected. The opinion that retrogression follows as a natural result of the cessation of selection is rejected by the author (p. 157), as we might expect, seeing that he does not allude to the conception of a condition of unprogressive equilibrium still requiring the unremitting aid of selection for its support. In this lecture, too, there is a further dogmatic statement as to the uselessness of certain structures or features. Among these the white under-side of flat fishes is instanced as probably due to disuse-inheritance (p. 160); but Abbott H. Thayer's interpretation of white under-sides generally may very probably be applied (as, indeed, Mr. Thayer believes) during the movements of these fish. The statement that "the thickness of the legs of the moas was of no advantage to them. On the contrary, it was distinctly a disadvantage" (p. 160), is an example of dogmatism concerning conditions of life of which we are extremely ignorant.

The author is inclined to believe in certain examples of "disuse-inheritance," although he generally criticises the evidence for "use-inheritance." He forgets that passive structures which are useful, but not physiologically altered by their own utility, degenerate when they cease to be useful, no less than the active structures which are modified by their own use. This argument, *mutatis mutandis*, affects equally the supposed use-inheritance.

In the case of certain New Zealand alpine plants, it is contended that there is good evidence for the transmission of an acquired character. *Olearia nummularifolia*, var. *cymbifolia*, produces leaves characteristic of the local alpine plants, but "the leaves on new shoots revert to the ordinary form if the plant is removed to the low land; thus showing that the peculiar shaped leaf is an acquired character and not inherited." On the other hand, the alpine *Veronica lycopodioides*, having a leaf similar to that of the *Olearia*, does not change when grown at a low level, "and we must, therefore, assume that an acquired character has here become congenital" (p. 165). The probable explanation is that natural selection has rendered the former species susceptible to

the influences of two very different sets of conditions, while the latter has been led by it to a single fixed form suitable to a single set of conditions. This is only a suggestion, and might require modification after a special study of the circumstances of the two species; but it is sufficient to show that we require far more evidence before it can be conceded that such transmission had been made in any way probable.

The book is well and clearly printed. A portrait of Lamarck forms the frontispiece. E. B. P.

THE RATIONAL TEACHING OF MATHEMATICS.

The Teaching of Elementary Mathematics. By David Eugene Smith, Principal of the State Normal School at Brockport, New York. Teachers' Professional Library. P. xv + 312. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.)

IN many training colleges for primary school teachers there are elaborate courses of study on psychology and ethics. Surely a knowledge of morals and of the mental machinery of boys and girls would be more certainly and more easily acquired incidentally during other studies, such as the natural sciences; but at these colleges there is seldom any attempt to educate through the natural sciences. We have, though not to the same degree, the same feeling about courses of instruction in mathematics. There is a cold-blooded formality about the mere name which tells all children truly that they are being offered stones for educational bread. But if there must, unfortunately, be separate courses of instruction in mathematics, we should, if we were children, dearly love to be taught by Mr. Smith. He is well read in his subject, and teachers who are also well read will take pleasure in seeing the best views so clearly put forward; teachers who are not learned in the subject will benefit greatly by reading this book. Short sketches of the histories of arithmetic, algebra and geometry are woven into the text in such a pleasant fashion that one reads and understands without much effort. The merits and demerits of various systems of teaching mathematics to very young children are clearly stated, but we cannot help thinking that too much is made of the philosophy of the numerous German exponents of pedagogy. There is no system which will give good results in the hands of a fool; there are many systems which will work fairly well in the hands of the average teacher; a thoughtful man who is in sympathy with his pupils will succeed with any method that he is likely to adopt.

Philosophers are too fond of distinguishing between teaching for *utility* and teaching for *culture.* We take it that even if we teach mathematics for its "bread-and-butter-value," if we teach so that a pupil really understands what he does, then we are really training his logical powers and giving him help in his ethical, religious and philosophical ways of thinking. The more we try to teach merely for culture the more do we make the reasoning obscure and difficult. As if a good teacher could possibly give sordid notions to his pupils! What we really want is that all teachers shall know their business, and then, however quickly they may make their children cover the ground of elementary mathematics, and we say the quicker the better, the children will be taught as rational beings. Much of the arithmetic taught in schools is really the teaching of a trade. A particular rule like *Practice* is merely the application of arithmetic to the trade of a grocer. So also rules like *Interest* or *Discount* are labour-saving rules, useful when one has thousands of calculations of the same kind to make, easily learnable by a boy after he leaves school if he has a knowledge of simple arithmetic and if his common sense has had a fair chance of development. Children may be kept for years at "rules" of arithmetic which they never understand, by an unscientific teacher, and this is what the philosophers condemn as utilitarian teaching. There is as little *utility* about such teaching as there is *culture* in that of the equally unscientific follower of the greatest psychologist. Of the two, however, the unscientific utilitarian does least harm, for he makes least pretence; he only stupefies the brain, the other destroys the soul.

Indeed, the man who aims exclusively at culture always hurts the soul of his pupil, for he teaches that what is useful must be low, and that the study of it must lead to sordid thought. We can no longer afford to laugh when men assure us that they scorn the results of their studies when these results prove to have useful applications. So long as these men were few in number they might be laughed with; we laughed because they were paradoxical and because we did not fear that the utility of a study could really be lost sight of. We are always grateful to philosophers who discover new truths, whatever their notions as to their utility may be. But when the stupid admirers of these men erect their paradoxes into articles of belief; when headmasters with much capital invested in teaching machinery find that such articles of belief give a fictitious value to their invested capital; when as a result, 98 per cent. of the boys leaving school at seventeen to nineteen years of age know no mathematics, although they are supposed to have been studying mathematics for many years; when we have overwhelming proof from the fields of war and commerce and manufacture that the best race of men in the world is held by want of education, as if by enchantment, from exercising its natural powers—then we feel that the time has come when a crusade ought to be preached against the pestilent heresy.

We are very glad to think that Mr. Smith gives great weight to the opinions of Profs. Henrici and Minchin about mensuration and geometrical teaching. Lacroix expressed them clearly, so did Clairaut and Voltaire and Hoüel and Spencer and Langley, and many another educationist. Laisant says, "But just as there must be a preliminary preparation for arithmetic—namely, practical calculation—so theoretical geometry should be preceded by the practice of drawing." Rousseau said that for young pupils "geometry is merely the art of handling the rule and compasses." Mr. Smith describes the use of shears and cardboard, and he suggests how to follow Galileo's experimental and inductive methods in mensuration, even with boys of intermediate grades. As for demonstrative geometry, Mr. Smith says that in America it usually begins in the tenth or eleventh school year.

"To begin a work of the difficulty of Euclid any earlier than this will hardly be sanctioned by American teachers; the hard Euclidean method must change, or the subject must remain thus late in the curriculum. If the object were, as seems to be the case in England, to cram the memory for an examination, it could be attained here as easily as there. But the considerable personal experience of the writer, as well as the far more extended researches of others, convinces him that as a valuable training in logic, as a stimulus to mathematical study, and as a foundation for future research, the study of Euclid as undertaken in England is not a success."

He then quotes Prof. Minchin, who says:—

"Why then is it that the teacher, when he comes to the teaching of Euclid, is confronted with such great difficulties that his belief in the rationality of human beings almost disappears with the last vestiges of that good temper which he himself once possessed? The reason is simply that Euclid's book is not suitable to the understanding of young boys."

We wish that Prof. Minchin had gone further and said that whereas every boy and man takes an interest in experimental science, including geometry and mensuration, only a few ever take an interest in demonstrative geometry; and it is both wrong and foolish to insist on its being learnt by boys whom it stupefies, whatever their age may be. All educationists are agreed that the English system of insisting on all young boys learning demonstrative geometry is quite wrong. Certainly, we know of no educationist who has a word to say in favour of the system prevailing in all English schools. We take it that the system is maintained because it does not "pay" the pupil in any sense whatever. Prof. Hudson is quoted as saying, "To pursue an intellectual study because it 'pays' indicates a sordid spirit." Working at geometry indicates no sordid spirit in our boys, but we are not so sure as to what it indicates in the masters of English schools. It "pays" them very well indeed.

Give the brains of an average English boy a chance of development, and he is full of common sense and self-reliance and scientific method; and yet the average boy leaves our schools uneducated, with no knowledge, and with the belief that he is stupid. Even Pythagoras did not think that more than a very few men were capable of the study of geometry; hardly one legislator or ruler or warrior from the time of Pythagoras to that of Pappus made a study of geometry, although this was a time when there were few kinds of intellectual study.

Mr. Smith's statements as to the history of the subject are fairly acceptable, as he keeps clear of debatable matter.[1] Throughout, he is unwilling to give Semites much credit, and I presume that it is in consequence of this that, in describing the work of Diophantus, the Alexandrian beginner in what we now call algebra, he forgets to mention that in all probability all the early life of Diophantus was spent among Asiatic peoples. Algebra, as we know it, dates from the time of Haroun of the "Arabian Nights." No doubt it comes altogether from the Semites of thousands of years before—the Semites who gave us all religions and the usages of older civilisations, without being able to give us their own subtler instincts; who taught Homer the decoration of a shield and Pericles how to beautify Athens; who gave Greece all its geometry through Pythagoras the Tyrian; who allowed Thales and Herodotus and other peripatetic students to absorb their science; who taught the doctrine of humanity to Socrates, and who did not mind taking to themselves Aryan names either in Troy or Alexandria or London.

The earnest reader of Mr. Smith's book will probably be led by it to think things out for himself. It is not important that he should subscribe to the author's opinions. Indeed, these opinions are rather in opposition to one another, for Mr. Smith is able to see that there is much to be said in favour of the views of almost all the writers whom he quotes. He gives many hints which will be found very suggestive by a thoughtful teacher of arithmetic and algebra who is not himself a good mathematician. They may, however, lead a common man to obscure the minds of his pupils, giving them, for example, all the historical methods of solving quadratics before they know much about quadratics. When one clears an equation of fractions by multiplying all across by some function of the unknown, the resulting equation contains other roots than the original one—yes, but it is not wise to trouble beginners with too much of this. One may philosophise deeply over our very simplest notions, but "Sartor Resartus" ought only to be read by grown-up people.

JOHN PERRY.

[1] As this notice was getting too long, we have cut out much of what we had written. We have here cut out some remarks as to the claim of Napier of Merchiston to the invention of the use of decimals. But it is rather important to re-write an observation made long ago by Prof. Ayrton:—"The units ought to be symmetrical with regard to tens and tenths, and it would be more scientific to write 1500·0032 as $15\bar{0}0032$ or $15\dot{0}0032$, or in some other way which shows its symmetry. It is astonishing what trouble is given by the difference in rules between finding the logarithm of a number like 500 and a number like 0·05. If they were written $50\dot{0}$ and $.\dot{0}05$ we should have the same rule for both. If we must retain the present unscientific method, let writers who wish to avoid printers' errors avoid ·05 and always write 0·05."

HUMAN ORIGINS.

In the Beginning (*Les Origines*). By J. Guibert, S.S. Translated from the French by G. S. Whitmarsh. Pp. xvi + 379. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1900.)

THE author of this book is the Superior of the Institute Catholique in Paris, but when he wrote it he was professor of natural science at Issy. The book is the outcome of an endeavour to train young ecclesiastics who, in the future, would have to propagate and defend the faith. It is rightly insisted as most essential that young clerics should be wanting in no knowledge concerning humanity; and it is pointed out that two perils of equal danger have to be avoided—an ill-founded compliance with the theories in favour amongst the learned, and a blind attachment to certain ideas which have no firm foundations, but which some men erroneously consider as identical with the faith. The author imposes on himself the three following obligations: (1) honestly to explain systems, (2) assert with firmness what is well established, (3) leave the questions open which have not yet received a solution; and he concludes his preface thus:

"If, as science advances, it should illuminate some doubtful point, or show the fallacy of some solution which I had looked upon as finally settled, I should not hesitate to yield myself to these indications. And if the Church, in whose infallibility I firmly believe, should deliver a judgment contrary to my assertions, I am ready, in advance, to accept her teaching."

It is interesting to note how this very earnest and conscientious teacher treats his subject, as he evidently endeavours to present the main results of scientific research to his readers so that they may be prepared for the shock of a possible future meeting with scientific doctrines which might imperil their faith.

The "Church" has, very wisely, not pronounced definitely on many scientific problems, and concerning these it is open to an intelligent Roman Catholic to hold fairly advanced views; for example, the cosmogony of the Bible is one of these, and the reader is permitted to take his choice of the three main interpretations of this account. The most, too, is made of our ignorance concerning the origin of life and the actual precursors of man. The author regards himself as an evolutionist, but he is not a thoroughgoing one, as he distinctly affirms that the theory of evolution can neither be applied to the origin of life nor to man. He asserts that

"evolution, even had it realised the progression which unites all animals in one nature, could not have produced that new creation which is known as an intelligent and free man."

The author admits that the volume has no scientific pretensions, and he goes on to say "were it judged with the utmost rigour it would not disturb me." All the same, the book would have been less open to criticism if it had been looked over by specialists, as there are many statements of theories or facts that, to say the least, it would have been much better to have put differently, and there are many errors of nomenclature and misprints that should have been avoided. For example, Noctiluca is called a "jelly fish" (p. 75), *Aurelia oecrita* (*sic*) is termed a Madusa (p. 82). As examples of errors of fact may be instanced, the Australians are credited with a "wide head" (p. 368); the Bushmen are degenerate Hottentots, and these, according to "eminent ethnologists," are "emigrant Egyptians, debased and deformed by misery" (p. 372).

We have given this book as much space as it deserves as a popular exposition of human origins; but nevertheless it is probable that it will be of service, as it should make some religious people think on subjects that they too often ignore, and, at all events, it will indicate to "good Catholics" that certain of their own religious teachers do not entirely repudiate modern science or entirely reject the theory of evolution.

OUR BOOK SHELF.

Atti della Fondazione scientifica Cagnola. Vol. xvii. Pp. xxvi + 355. (Milan: Tip Bernardoni di C. Rebeschini, e c., 1900.)

UNDER the Cagnola foundation, two prizes are annually awarded for essays on subjects proposed by the founder, and one prize of about 100*l*., with a gold medal of the value of 20*l*., are awarded on a subject chosen by the Reale Istituto Lombardo. The theme for 1898 was a critical exposition of the theory of electrical dissociation, and the successful memoir by Profs. Angelo Battelli and Annibale Stefanini forms the subject of the present volume.

Among the various theories of solution, that of van 't Hoff, which regards the dissolved substance in a dilute solution as existing in the gaseous state, has found much favour; but determinations of molecular weight derived by this hypothesis do not agree, especially in the case of electrolytes, with those obtained by other methods or deduced from the chemical formulæ. This circumstance, coupled with the fact that the least electromotive force suffices to generate a current in an electrolyte, had already led Clausius to replace the hypothesis of Grotthus by other theories; and Arrhenius, observing that the anomalies in the osmotic pressure and the freezing-points occur exclusively in solutions of electrolytes, was led to the hypothesis that these contain the acids and salts in a state of dissociation, increasing with the dilution.

This hypothesis of electrolytic dissociation has been put by the authors to a variety of tests in connection with the mechanical phenomena of osmotic pressure, optic phenomena, thermal phenomena connected with freezing- and boiling-point determinations, and, lastly, electric phenomena; and while many of the results favour the hypothesis of the existence of free ions in solutions, others are difficult to reconcile with this theory. Thus the degree of dissociation required to account for optic phenomena does not always agree with that deduced from cryoscopic or ebullioscopic observations, or from electric conductivity. Moreover, the authors do not consider it conclusively proved that there is no inferior limit to the electromotive force sufficient to set up a current in an electrolyte.

It will be thus seen that Profs. Battelli and Stefanini have opened up a wide field of discussion in connection with electrolytic theories, and that their work, both theoretical and experimental, will be of no small assistance to chemists and physicists interested in researches in this subject.

An Elementary Treatise on Qualitative Chemical Analysis. By Prof. T. F. Sellers, A.M. Pp. 160. (Boston: Ginn and Co., 1900.)

THE author justifies his contribution to the long list of analytical works by pointing to the inevitable gap. The gap no doubt exists. The question is whether it is desirable to fill it. We have analytical books which mean business, and, being written for analysts and not for students, are crowded with practical details. Then there are the countless examination cram books, which by tabular and other devices direct the student by the shortest cuts to his ultimate goal—the discovery of the constituents of salts, simple and complex. The present little volume is to fill the gap which lies between these two extremes, and its advantages are set forth in the preface under six principal heads and eight subsidiary ones. Without transcribing literally these manifold recommendations, it may suffice to say that the book opens with the principles of analytical chemistry by introducing the theory of solution, osmotic pressure and electrolytic dissociation, and proceeds with the usual series of qualitative tests for bases and acids and their methods of separation.

However desirable it may be for even an elementary student to gain some knowledge of analytical chemistry based upon the modern theory of solution, a beginner should first be confronted with his experimental facts. A reversal of the present order might therefore be adopted with advantage. An advantage, too, would be derived from the introduction of a few illustrations, descriptive of the apparatus mentioned in the text.

As to whether a student, such as the author contemplates, who does not intend to specialise in chemistry, gains very much from the detailed study of analytical operations, is open to question.

The study of qualitative analysis as a substantial part of elementary practical chemistry has been determined largely by tradition, partly, too, by the exigencies of examination, to which it readily lends itself; but it is worth consideration whether the emphasis laid upon it

on these grounds is not exaggerated, and whether a student who studies chemistry for one year could not fill his time with practical problems of greater value.

J. B. C.

Microbes et Distillerie. Par Lucien Lévy. Pp. vi + 323. Paris: Carré et Naud, 1900.)

THIS book, which deals with the micro-organisms connected with distilling operations, supplies a good illustration of the rapid progress that is being made in the study of technical mycology. M. Lévy confines himself strictly to his subject, and does not wander into the details of practice, and yet the three hundred and twenty odd pages of his book are none too many for a very brief *résumé* of much that is known concerning the relations of micro-organisms to the distilling industry. But brief and condensed though it is, it is accurate and very fairly complete, and, moreover, possesses that charm of simple rendering which is so characteristic of the best class of French scientific literature.

The book will be useful to all interested in the technology of the fermentation industries; but we are inclined to go farther, and also recommend it to the notice of students of pathogenic micro-organisms. There appears to be some little danger of too wide a separation of this branch of bacteriology from the science as a whole, and any such artificial division can only work for harm. Probably much of the knowledge gained concerning the micro-organisms of fermentation and their actions has some bearing on pathological bacteriology, and for this reason we recommend M. Lévy's book to pathological bacteriologists as a concise and suggestive *résumé* of another branch of their science. Doubtless it reflects more especially the work and views of the French school, but then it is published in the land of Pasteur.

A. J. B.

The Fifth Report upon the Fauna of Liverpool Bay and the Neighbouring Seas. Edited by Prof. W. A. Herdman, F.R.S. Pp. ix + 336. Twelve plates. (Liverpool Marine Biology Committee, 1900.)

THE reports and other publications of the Liverpool school of naturalists have provided material for many paragraphs in our "Notes" columns, the latest "Memoir" published by the Liverpool Marine Biology Committee having been noticed quite recently (p. 330). The present volume contains reprints of the annual reports of the Committee, from the ninth to the thirteenth inclusive, papers communicated to the Biological Society of Liverpool on Copepoda, Hydromedusæ, Turbellaria, Actinia, and an abnormal Echinus, and a list of the marine fauna and flora of the Irish Sea. The record of the L.M.B.C. is brought down to the end of its sixteenth year, and observations extending over several years, referring to the marine biology of Liverpool Bay and the Irish Sea, are rendered available in a convenient form. The volume stands as substantial evidence of what valuable work a few good naturalists can do, even when the financial resources are limited.

Analytical Tables for Complex Inorganic Mixtures. Arranged by F. E. Thompson, A.R.C.S. Pp. 7. (Stafford: *Chronicle* Office.) Post free, 1*s.* 7*d.*

A SERIES of tables suitable for use in chemical laboratories where students are working at qualitative chemistry, with an examination like that of the advanced stage of practical inorganic chemistry of the Board of Education in view. The tables show how to conduct a preliminary examination of a substance in the dry way, and in the wet way for metals; and they describe the usual treatment of group precipitates and filtrates. There are also tables for examination for acids and giving confirmatory tests for acids.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mathematics and Physics in Public Schools.

A WELL-ATTENDED conference of science masters in public schools was held last month at the University of London, and among the many interesting papers read was one by Mr. W. D. Eggar, of Eton, on the coordination of mathematics and physics in our public schools.

In answer to that paper I endeavoured to point out at the time that the present want of cohesion between these studies was due, not to the incapacity of the instructors in these subjects, but to the illiberality of the system still prevailing, not only in the Universities to which many of the boys eventually go, but also to an equal degree in these public schools themselves.

I will here take the opportunity of thanking the editor of NATURE for his courtesy in inviting me to express my views at greater length. This letter is a plea for a change in the order of teaching mathematics in the older public schools, and contains a suggestion as to how such a change could be effected.

The points I wish to call attention to in this letter are that (1) the hands of mathematical teachers in these schools are tied by the conditions of the University examinations; (2) in arithmetic more attention should be paid to the decimal system; (3) the Euclid should be curtailed and some of it put into algebraical form; (4) too much time is given to artificial questions in algebra; (5) trigonometry ought to be begun earlier; (6) more hours might be allotted in the week to mathematics and physics; and (7) the classics are given an abnormal and unjustifiable preponderance in an ordinary boy's education.

I am quite aware that the difficulties to be overcome in effecting any rational common-sense change in the methods and order of teaching elementary mathematics will be very great, but let us hope they will not prove insurmountable.

To begin with, the public schools for boys of average ability are bound to more or less base their scheme of work on the pass requirements of the Universities, though perhaps at Eton this may be less the case than at many other schools. After those requirements have been satisfied the teaching does not by any means always shape itself in the direction of the work a boy may afterwards follow while at the University or in after life. As things are, what is the present condition of the average boy at our older public schools?

In arithmetic he gains a certain amount of proficiency in those fractions known as vulgar, he learns the artificial rules for extracting square and cube roots, he works out problems involving questions of time and work, or of time and distance, or of areas, he becomes quite proficient in the ordinary matters of compound interest, discount, stocks and shares, and he even gains an idea of what a stockbroker is. I am not prepared to say that all this has not its educational, and even its commercial, value later on, for it certainly has; but what I maintain is that we do not go far enough. There is not enough chance, our pass examinations being what they are, of boys seeing the value and importance of the decimal system as applied to physical measurements and problems. They are often apt to imagine that a result must be absolutely correct to its last decimal place, or it is valueless; and the methods of approximation are often excluded from their course altogether, either as being not sufficiently accurate or not required for the University entrance or pass examinations.

Let us turn now to the question of Euclid. Geometry is an excellent form of mental gymnastics when it is taught in the proper way, but the manner in which it is presented to the boy in our editions of the great geometer is antiquated and out of date. Far too much in this abstract science is left to the imagination, a quality which the ordinary boy frequently lacks; and ocular demonstration is but little resorted to in order to give him, by means of figures and models cut out of cardboard, a clearer idea of what he is required to prove. I also venture to think that the Euclid, such as we know it, is spun out to an excessive length, and too often the patience and courage of the average boy is well-nigh spent before he gets to the end of it.

I am fully aware of the existence of that useful body known as the Association for the Improvement of Geometrical Teaching, or, as it is now called, the Mathematical Association, of

which I have the honour to be a member, but it is a large problem which it has to face, and it is to be hoped that its publication will not fall too much into the way of merely publishing solutions of interesting and sometimes recondite conundrums.

I should like to see a more rational form of geometrical text-book in common use, in which many of the propositions of the second and fifth books are merely translated into algebraical language, and ratios and symbols more widely employed in the sixth book to shorten many of the propositions.

Again, no doubt, trigonometry is postponed till too late a date, and in many cases it is not begun at school at all. Why should not every one gain a reasonable notion of the sines, cosines and tangents of angles at a much earlier stage in order to supplement his knowledge of geometry? I would not recommend a beginner to employ himself for hours, as is often the case, in proving long, and to him cumbrous, identities, but leave such work to the professed mathematician. It would be more profitable for the boy to plot out graphs of the simpler functions on squared paper and thereby gain an early notion of coordinates. He should also be taught much earlier a practical working of logarithms, and not postpone it until perhaps he has got beyond the binomial and experimental theorems.

What do we find, too, in the teaching of elementary algebra? There seem to be the same unpractical methods at work here. Boys spend considerable time over the ordinary rules in the early part of their text-books, and often no suggestion is made to them that algebra is but a convenient method of expressing general ideas in a shorthand form. The fundamental notions of ratio, proportion or variation are kept from them because, if you please, the chapters on them are printed somewhat late in their text-books! Too frequently the average question merely involves a bristling array of letters and brackets which have to be simply eliminated or removed. Seldom is an appeal made to a boy's faculties of sight and touch, and seldom is any apparatus for measurement placed in his way. The present order of things may not do much harm to the boy of mathematical ability, if he means to make a special study of the subject; but for the rank and file it is wrong, if they are to coordinate their mathematics with a good working knowledge of the calculus of experimental science.

Here I must make mention of a very valuable article by Prof. Perry in NATURE of August 2, 1900, and I only regret that, as I was away at the time, I was not aware earlier of its existence. I need only say that I am heartily in accord with him in advocating some such scheme as he there proposes. To turn now to what I hope may prove a practical suggestion. It would not be possible to change abruptly from the present arrangement to such a scheme; but the process could certainly be gradual, and a larger, gradually increasing, proportion of hours for experimental work might well be introduced into the curriculum. Surely the University of Cambridge might lead the way and bring into its previous examination some form of physical science, theoretical and practical, in order that all young men may obtain some idea of the practical applications of mathematics. Why is it that so many young men at Cambridge find the subject of physics so difficult, and are sometimes induced to abandon it for some other form of science? My answer is that their previous mathematical education has often been conducted on the wrong lines, and their knowledge is not of that kind which is required of them in the laboratories.

The University of Oxford is, however, a far worse offender in its mathematical papers for responsions and matriculation. The arithmetical papers set are thoroughly on the orthodox lines, and this is very well as far as it goes; but there is no hint of any application of arithmetic to practical work. The rest of the mathematics required is truly ridiculous; a candidate may either take an elementary algebra paper, carrying him about half-way through the subject, or a paper on the first two books of Euclid, and the latter alternative is strongly recommended by the authorities. Note that he must not take *both* subjects, so that the candidate is given to understand that these two subjects are divided off into separate compartments, and may have no more relation to one another than biology has to Greek iambics. Moreover, from what I understood in a speech at the Conference of Science Masters, a young man who would offer physics for a scholarship does not always meet with the encouragement he deserves from the authorities at certain colleges, and *a fortiori* no pass candidate is expected to even trouble himself about the subject.

With these difficulties in our way it cannot be expected that very much towards realising Prof. Perry's ideal has yet been achieved; but, in addition to what I have said, there is no doubt that the number of hours given to the study of mathematics or physics at our older public schools is woefully inadequate. It is useless to say that so much money is spent on these subjects. Unless more time is given to them for each individual boy, satisfactory results cannot be produced, much less can an advance be made towards coordinating the two subjects.

A great debt of gratitude is due to men like the late Prof. Huxley in furthering the cause of science in the public schools, but we do not want to stay where we are. An answer to the practical question of how we are to fit more time into the working day involves the removal of compulsory Greek and an alteration of the classical scheme. Education is very much in the air just now, and when Lord Rosebery, Sir John Williams and others, in the last few months, speak publicly upon this subject, it is greatly to be hoped that reforms will be brought about.

The old theory is, that it does not much matter what a boy is taught at school provided he is made to work. This, to my mind, is a most mischievous doctrine. The average boy has only a limited capacity and a limited time for learning to fit himself for his life's work, and it must be discouraging to him to find, when he leaves school, that he knows absolutely nothing about the work by which he may be going to earn his bread. Not every boy is capable of becoming a classical scholar with a fine critical instinct; let those who are by all means be encouraged in every possible way. But it is for the average boy that I plead, and I ask why so much of the old studies should be thrust down his throat when modern life will require of him a knowledge of a great deal besides.

I do not desire to enter into a long discussion of the merits of a classical education, but in the older public schools some change must be brought about if we are to devote more time to modern subjects, and it is for this reason that I have introduced the question here. A spirit of quasi-mediævalism still seems to be numbing the existence and warping the educational growth of these schools. Far better would it be if a change came about from within; but will anything short of another Royal Commission bring about the necessary reforms?

Athletics fill a large part of school life, and it is natural that they should appear important on a healthy boy's horizon. It is, therefore, all the more necessary he should be properly guided in his work before the time comes when he can judge for himself. Perhaps too much time may be given to sports; be that as it may, a boy in each day cannot work more than a certain number of hours, but while he is at work, for heaven's sake let us teach him more of the things which are likely to stand by him afterwards. I have too much respect for the older public schools to wish to see them left behind in the race by vigorous younger sisters; but we, who are concerned with such schools, cannot shut our ears to the peremptory demands for a more rational education, if our national life and character are to play the same part in the future that they have done in the past.

G. H. J. HURST.

Eton College, Windsor, February 12.

The Use of Mosquito Curtains as Protection against Malaria.

IN your issue of December 20, 1900, is described the use of mosquito curtains against malaria in Egypt. It is, I suppose, generally known that in India they have been used for many years in a similar fashion. Between 1872 and 1883 I travelled and camped in some of the most malarious jungles in India. Sometimes I had to travel, like a Boer, in light marching order; but mosquito curtains, I can well remember, were the last things to be left behind. Their efficacy in those days was attributed to a filtering action; and, following out this idea, I used (especially in very feverish districts) to employ curtains composed of thin porous sheeting. I can still recollect the various stories of the efficacy of mosquito curtains against malaria.

There seems to be an opinion amongst men who go north into the malarial districts of Rhodesia, &c., that Dr. Ross's splendid discovery does not cover quite the whole ground. One can recollect how, in certain countries, certain winds (apart from mosquitoes) inevitably bring attacks of fever, even in those who are apparently free at the time from infection. On the Nilgiris, in Southern India, between 6000 and 7000 feet high,

malarial fever is unknown on the spot, but a man may turn over the ground in certain marshy localities and get fever certainly whenever he does so. It was common experience in India that the drinking of certain water, such as that from the highly malarious Western Ghaut forests, would inevitably cause malarial fever.

In many malarious localities, especially parts of China, it is sufficient to turn the ground over to apparently poison the atmosphere and induce malaria in those who are near. There is a medically authenticated case of fever being contracted from newly turned-up earth carried in baskets by coolies past a window. When this and other cases come to be re-examined they may be found traceable to mosquito-born Hæmamœbidæ; but it is difficult to account for them all in this way, and, as I mentioned, there seems to be an opinion amongst Northern men here that all cases of malarial fever cannot be attributed to Anopheles infection. D. E. HUTCHINS.

Conservator of Forests, Cape Town, January 19.

Audibility of the Sound of Firing on February 1.

I ENCLOSE a record of the sound of the guns heard at Eastbourne, commencing at 3h. 14m. and ending at 3h. 57m. As you will see, the sounds came with great regularity every minute, but the period which the sound covered in each minute gradually fell off from eleven to about five seconds. My observations were checked by a friend, and we were stationed on the summit of a down some 500 feet above sea level with a clear sea horizon out to Newhaven. The distance to the Solent is about sixty-five miles, and there was a slight wind from the North-West. I should like to try to describe the sounds which, though faint, were perfectly distinct—er-er-er-pup-er-er-pup-pup, the detonation sound being more marked towards the end of each period. I need not say that the sounds were indescribably mournful to listen to. H. D. G.

Audibility of the Sound of Firing on February 1st.

Sound commenced at h. m. s.	Sound ended at h. m. s.	Duration of sound s.
3 14 7	3 14 18	11
3 15 8	3 15 19	11
3 16 8	3 16 18	10
3 17 8	3 17 19	11
3 18 8	3 18 19	11
3 19 8	3 19 19	11
Observations interrupted by the rumbling of the wheels of a cart about a quarter of a mile distant.		
3 23 11	3 23 19	8
3 24 12	3 24 19	7
Observations again broken by sounds of a distant cart.		
3 27 13	3 27 19	6
3 28 13	3 28 18	5
3 29 11	3 29 17	6
3 30 11	3 30 16	5
3 31 12	3 31 16	4
3 32 12	3 32 13 (?)	1
3 33 12	3 33 16	4
3 34 11	3 34 15	4
3 35 11	3 35 15	4
3 36 11	3 36 15	4
3 37 11	3 37 15	4
3 38 10	3 38 16	6
3 39 10	3 39 17	7
3 40 11	3 40 15	4
3 41 10	3 41 15	5
3 42 10	3 42 15	5
3 43 10	3 43 15	5
3 44 10	3 44 15	5
Observations again interrupted.		
3 46 11	3 46 14	3
3 47 10	3 47 16	6
3 48 9	3 48 15	6
3 49 9	3 49 15	6
3 50 10	3 50 15	5
Failed to hear sound—reports growing fewer and very faint.		
3 52 13	3 52 16	3
3 53 10	3 53 15	5
3 54 11	3 54 14	3
Reports continued until 3 57—but impossible to time—so very faint.		

Sensational Newspaper Reports as to Physiological Action of Common Salt.

IN the interest of the dignity of scientific research I venture to hope you will print the following statement. Some American papers have recently published sensational and absurd reports of physiological theories and experiments whose authorship they attributed to me. These reports, which in America nobody takes seriously, were reprinted and discussed in European papers. I hardly need to state that I am in no way responsible for the journalistic idiosyncrasies of newspaper reporters and that for the publication of my experiments or views I choose scientific journals and not the daily Press. JACQUES LOEB.

The University of Chicago, Physiological Laboratory, January 16.

The Publication of Books without Dates.

Is it not time that men of science should raise a protest against the publication of books without a date on their title-page? This is a practice which has been common to maps and a certain class of books of reference, and it comes, to my mind, very near to being a deliberate fraud, as it seeks to pass off as new that which is more or less obsolete. We should surely do our utmost to prevent this habit from spreading to scientific books, such as the translation of van 't Hoff's "Physical Chemistry," which is reviewed in NATURE of February 7. O. HENRICI.

Central Institution, Exhibition Road, February 9.

Optical Illusion.

IT seems to me certain that the phenomenon illustrated in NATURE of February 7 (p. 353) is due to (1) *fatigue*, the cause of the reversed image seen when one looks away from the diagram on to white paper, combined with (2) *involuntary and incessant slight movements of the eye.*

Of course the reversed image, white squares and black lines, when one looks away on to white paper, is well known. With me it does not appear to occur at once, but after an interval; and it is intermittent, fading and recurring several times.

Now, when one gazes at the diagram, the eye moves incessantly to a slight extent; and so it is only the central part of the images of the white spaces that fall always on parts of the retina continually fatigued; the edges, near the black squares, fall on parts of the retina that have, on the whole, a good deal of rest owing to the fact that they are occupied for half the time (or so) by the images of the black squares. I do, in fact, see dark lines along the central portions of the white spaces, and the dark patches spoken of are where these dark lines cross.

I can make the horizontal dark lines disappear by purposely giving my eyes a more than slight movement up and down the vertical white spaces. Then the vertical shadowy lines, in the middle of these spaces, remain; the horizontal dark lines vanish, as should be the case.

As regards the "vanishing" of a patch looked at, I do not find this to be a correct account of what I observe. I notice that when I suddenly gaze at any one crossing, the crossing dark lines and dark patch at that place take longer to appear; but they do appear in time. Perhaps the "yellow spot" is slower in action than the rest of the retina in questions of fatigue? But these phenomena are difficult to observe, as the eyes soon tire. A very noticeable phenomenon, I suppose an extreme case of fatigue, is the following. When I gaze for a long time, white spaces here and there disappear altogether in a fitful manner, the squares concerned for the time blending. This occurs with monocular vision as well as binocular, as do all the phenomena mentioned. But I think the eyes must be very tired for this to occur.

As regards the question of spacing, I imagine that the steadier the eye-muscles, and so the less the involuntary movements, the narrower might be the white spaces. I have noticed a violet margin round an orange on snow, due to the same causes. It increased when the orange was rolled. The explanation is obvious if the view taken above is right. W. LARDEN.

R.N.E. College, Devonport.

Some Animals Exterminated during the Nineteenth Century.

Re the very interesting article published under the above-mentioned title by Mr. R. Lydekker (p. 252, January 10), may I indicate and correct an error? *Camptolaemus labradorius* is certainly exterminated on the North Atlantic coast of America, as Mr. Lydekker says; but this breed still exists not very far off, but in a somewhat out-of-the-way place, in the island of Anticosti, where M. Paul Combes saw it recently, as he states the fact in his "Exploration de l'Ile d'Anticosti," 1896 (J. André, publisher, Paris). HENRY DE VARIGNY.

Paris.

IN reference to the foregoing letter, it may be mentioned that the duck in question is entered as extinct in the "A.O.U. Check-list of North American Birds," 2nd ed. p. 56 (1895), and no information has subsequently reached this country as to its alleged survival in Anticosti. R. L.

THE PRESERVATION OF PHOTOGRAPHIC RECORDS.

AFTER the article by Dr. W. J. S. Lockyer on the disappearance of photographic images (p. 278) and other references that have been made to this subject, there is no need to dilate upon the importance of the preservation of the vast number of photographic records now being produced in our observatories and laboratories. I would, however, venture to express surprise that the fact established by Dr. Isaac Roberts as to the want of permanence of a silver photographic image appears to have been unexpected, bearing in mind the general procedure that appears to be the rule in the production of such photographs.

Photographic procedure is based chiefly, practically speaking, indeed, entirely, upon "rule of thumb," and if each modification requires a ten years' trial of it to establish its advantage or otherwise, it is at least desirable that more attention should be paid to the principles which govern the production and the permanency of photographs. It is well known that metallic silver is liable to change, yet we cannot get away from the use of silver salts, and these, of course, give silver images. *But silver ought never under any circumstances to be relied on.* The questions that present themselves, therefore, are: (1) how best to preserve the original silver image, and (2) how best to copy it.

It has been suggested to give up gelatine and go back to collodion. But this suggestion appears to be founded on nothing better than the quite insufficient evidence of general experience, and partly, also, on false inference. Metallic silver, we know, is affected by the air, and in a wet collodion plate the silver lies chiefly on the surface of the film, while in the ordinary dry plates it is buried in the gelatine. Moreover, experienced photographers tell us that the image on wet collodion plates gets denser with age. If it does so the image is unstable, and change, however it manifests itself, must be avoided if the photograph is to be accepted as trustworthy. The coarser grains and crystalline character of the image produced on wet collodion would account for its superior resisting power to outside influences, but this alleged superiority has not yet been proved. We cannot go back to collodion, but under any circumstances there appears to be no good reason for expecting any gain in that direction. Gelatine is the medium of to-day, and no evidence of its unfitness has been adduced.

Metallic silver is soluble in such reagents as dissolve silver oxide, if air or an oxidiser is present. Ammonia, potassium cyanide and sodium thiosulphate readily dissolve silver in the presence of air. The oxidation products of developers act as oxidising agents. Ferric oxalate, the product of development with ferrous oxalate, is particularly active in attacking silver, and is practically used for the purpose of thinning silver images. And the coloured products of oxidation of alkaline developers are well known to retard the reduction of silver salts, though apparently they have not been shown to be able to directly attack the metal itself. But it must be remembered that that which produces no appreciable effect in a few months, or even years, may have a disastrous action in a generation, so that the only safe course is to eliminate or exclude every suspicious substance. In short, the photographic film should consist of pure silver in clean gelatine, for anything more than this that is likely to be present will, in all probability, prove deleterious.

There is no difficulty in banishing at once ammonia, ferrous oxalate and potassium cyanide. The ammonia in the developer is replaced by sodium carbonate, an exchange in every way advantageous, the ferrous oxalate by alkaline developers, a change which has already met with general approval, and potassium cyanide as a fixing reagent is practically obsolete. The two great dangers that are not sufficiently appreciated by many photographers are the presence of thiosulphate from the fixing bath and oxidation products from the developer. To remove the first, the usual half-hour of washing is not sufficient, however the water may be applied. There is no particular virtue in running water or in washing contrivances; it is the prolonged soaking in clean water that is wanted. However the washing is done, it is easy to remove the greater part of the thiosulphate; it is the last traces that are hardly, if at all, susceptible to detection by any of the ordinary methods that need attention. If after half an hour it is not possible to detect any thiosulphate in the wash water, a further soaking for an hour and a half, with suitable changing of the water, would not be excessive treatment.

The same washing that gets rid of the fixing reagent washes out the developer and its oxidation products, if the work has been carefully and successfully done. But to ensure this the developer must have sufficient sulphite (sodium sulphite) in it to prevent its discoloration or the staining of the film. The deposition of staining matter should be prevented, as removal is tedious and troublesome. Many published formulæ for developers prescribe an insufficiency of sulphite, and it is not possible to state definitely how much is required, because that will depend on the time taken for development and the amount of sodium carbonate present. But generally, if not always, and certainly when using pyrogallol, the sulphite should be proportioned to the bulk of developer—that is, to the water; it is unsafe to dilute the prepared developer without adding the further quantity of sulphite to maintain its due proportion.

The method generally adopted at the present time to get rid of stains is founded, like so many other photographic methods, on a false basis. The idea is that if a stain disappears, it has gone. The appearance, truly, has gone, but the matter that constituted the stain may remain, and perhaps in a more dangerous form than it was at first. In almost all cases the effect of acids on stains due to oxidised developers is to lighten the colour of the staining matter and to render it insoluble. The action of alkalies is to darken its colour and to render it soluble. Alkaline solutions are, therefore, true clearing reagents, while acids are actually prejudicial, although they appear to effect improvement. It is desirable to carefully avoid the use of any acid solution whatever, and by doing so it will be found that cleaner and chemically purer plates are produced. After developing in an alkaline solution and rinsing the plate, it should be fixed in a solution of sodium thiosulphate made alkaline with sodium carbonate, and then well washed. The washing may be done with plain water, but if there is the slightest trace of colour due to stain, it will be found of advantage to add a little carbonate of soda or a very little caustic soda to the first wash waters. Acid fixing baths should be absolutely eschewed. The very grave risk that accompanies their use is not appreciated, or they would never be recommended.

Having thus obtained a really clean (that is, chemically pure) plate, the exposed surface of the film must be protected in some way to keep the image as much as possible from the air, and also to prevent contamination by the acid perspiration from fingers when handling it.

For this purpose a celluloid varnish will be found a better protection than the ordinary lac varnishes, but whatever is used it is desirable that the gelatine be dried before it is applied. By warming the plate until it is as hot as the hand can bear, and then allowing it to cool to the desirable temperature for varnishing, even though the varnish may have to be applied to the cold plate, the film is probably effectively dried. But what seems to be a much more effective method of preserving the film from outside influences is to cement on to it a cover-glass by

means of Canada balsam, and this is not difficult to do after a little practice.

By thus securing, as far as possible, an image of pure silver in a clean gelatine film, drying it and sealing it up, the photographer will have taken what appear to me to be the best steps possible to preserve the photograph. It may be a little more trouble than the ordinary routine, but hardly so much trouble as is involved in the practice of other photographic methods, such as wet collodion or daguerreotype. But whatever the trouble, nothing short of such treatment as has been indicated will give the photographer the satisfaction of knowing that he has done his best to preserve his plates. I have not referred to toning, although so great an authority as Sir William Crookes has recently referred to it, because a toning process gives a more complex image, and therefore a more difficult one to deal with, but also, and chiefly, because toning is an incomplete operation, and so gives an image of varying composition, and can hardly, by the nature of the action, produce a proportional change throughout the whole image. The fainter detail will be proportionately more affected than the denser parts. Measurements of the effects of the light are thus rendered impossible, or at least doubtful, and so useless.

But whatever care is taken to secure the preservation of the original plate, if it is valuable or likely to become valuable, it alone should not be trusted as the only record of the result it bears. Within a comparatively short time of its production, say within a few months, one or two prints should be obtained from the plate. These prints should be produced in the most simple manner possible in order to avoid personal bias or other possible errors consequent on a multiplicity of manipulations. They should be of the nature of printed-out prints, because a developed print (such as one on bromide paper) allows much scope for variation. Obviously the prints must be permanent. Platinum and carbon prints are the only ones that fulfil these conditions. Both are stated to require "development," but this is a misapplication of the word, or a different application from that which refers to the development of gelatino-bromide plates. The point is that the full chemical effect in both platinum and carbon prints is produced by exposure to light alone, the after treatment only utilising the change. A platinum print is probably more trustworthy as to permanency than a carbon print. The paper used must be of excellent quality, or the sensitive coating would be interfered with, and there appears to be nothing whatever that will affect a platinum image, unless, indeed, it is treated with chemicals that disintegrate the paper at the same time. Platinum prints, however, are not the best agents for showing fine detail or very small differences of density. In this respect they may be improved and much additional brilliancy imparted to them by applying any of the waxing preparations made for waxing prints. For rendering delicate tones, doubtless a carbon transparency would be superior to a platinum print. But if a photographic plate is of such a character that it is desired to preserve its record as nearly as possible for ever, it would not be an undue precaution or an excessive trouble to make two or three platinum prints as well as a carbon transparency from it. If the original plate is to be preserved by sealing it up with Canada balsam, then it should be varnished with a lac or similar varnish for getting the prints. The varnish could then be easily removed, if necessary, before the sealing up of the plate, or a varnish might be used that would be unaffected by the balsam. But on no account whatever must an unprotected film be touched by any platinum paper, carbon tissue, or any paper upon which a printed-out image can be produced, because all such papers contain soluble substances that prejudicially affect the image.

By working on the lines indicated, I think that it would be difficult to set a probable maximum limit to the duration of photographic records. We know how few years are sufficient to produce a measurable deterioration in many of the photographs as at present produced.

CHAPMAN JONES.

A LANCASHIRE COLLEGE.[1]

MR. HARTOG and the authorities of the Owens College are to be congratulated on their work, which owes its origin in part, to quote the words of the preface, "To a request from the committee of the Education Exhibition, held in London in January last, that the authorities of the college should furnish an account of the institution for that Exhibition and for the Paris Exhibition, to which it was preliminary, in part to the desire of the authorities of the college for a record of its development and present condition in celebration of its jubilee."

The introductory chapters deal with the history of the college and its buildings, its government and finance, and its relation to the Victoria University. Then follow details of the classes and lectures, with particulars of the special departments and of other allied institutions, lists of fellowships and prizes, and, lastly, a striking record of original publications by members of the college.

It appears that the earliest attempt to establish a University in Manchester was made in 1640, when Henry Fairfax presented a petition to Parliament in favour of this course. The opposition of the city of York killed the project; the next similar attempt was made in 1877, but the opposition of the city of Leeds led to the establishment of the Victoria University.

Between these dates various efforts were made to promote a college for higher education in the city; none of these, however, met with marked success until, in 1851, the Owens College was founded in accordance with the will of John Owens, a Manchester merchant and spinner.

The first chairman of the Owens trustees was George Faulkner, the friend and partner of the founder, who, it is said on good authority, refused to become Owens's heir, and persuaded him to found a college. Owens's bequest realised about 90,000*l*., and, in accordance with the founder's decision, the income from this was spent mainly on the provision from the first of an adequate teaching staff. To this Mr. Hartog with justice attributes a great share in the ultimate rise of the college. The histories of Owens College and of University College, Liverpool, a sister member of the Victoria University, teach the same truth. Owens College began in a hired house; University College in a disused lunatic asylum; but in both cases the devotion and splendid energy of the staff won in time the confidence of large-hearted men and women in their respective towns, and though the equipment of neither college is yet complete, the laboratories and class rooms, museums and libraries bear striking testimony to the wisdom of those who moulded the institutions in their early days.

Owens College began with five professors and two teachers. To-day its staff consists of thirty professors, thirty-four independent lecturers, and thirty-nine assistant lecturers and demonstrators.

But success did not come at once; the number of day students, which at first was sixty-two, in 1857 dropped to thirty-three; the local newspapers pronounced the scheme to be a mortifying failure. The trustees and the staff, however, held their course, and from 1858 onward the numbers have gone on increasing until, during last session, they reached the total of 1002. A building fund,

[1] "The Owens College, Manchester, founded 1851. A brief History of the College and Description of its various Departments." Edited by P. J. Hartog, B.Sc. Pp. viii + 260. (Manchester: Cornish, 1900.)

which ultimately realised 106,000*l*., was started in 1867, and the first permanent buildings were opened in 1873.

About the same time a fundamental change took place

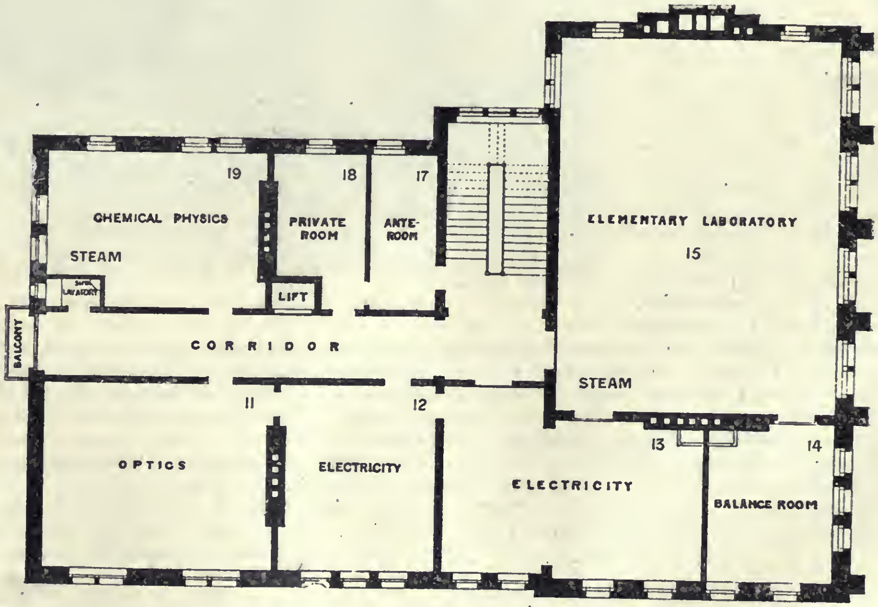
FIG. 1.—Physical Laboratories, Owens College.

in the government of the college, which passed from the trustees constituted by the founder's will to the governors, council and senate appointed under the Owens College Act.

The funds of the college were largely increased by the Clifton bequest of 21,500*l*. for the engineering department and the Beyer bequest of over 100,000*l*., received between 1876 and 1887. Since that date the legatees of Sir Joseph Whitworth have given about 120,000*l*. The capital is now 866,000*l*., of which 418,000*l*. is sunk in land buildings and appliances; almost the whole of this sum is due to private benefactions. The income for the session 1898–99 was 39,000*l*., and of this about 17,000*l*. was derived from students' fees, 12,700*l*. from special endowments, and 4,500*l*. from Government and other public funds.

These figures give some idea of the magnitude of the work done by the college, though in spite of the efforts made there is a continually recurring deficit. Increase in the number of students means a disproportionate increase in laboratories and teaching appliances, which cannot be met by an increase in fees; each extension of buildings involves increased cost in maintenance, rates and establishment. While private generosity has done much, the number of donors is not very large, and the amount received from public funds bears no proper proportion to the work which the college is doing for the city and county. In 1898, the Manchester Corporation contributed 700*l*. for technical instruction and 400*l*. for the museum, while the Lancashire County Council gave 250*l*., to be raised to 500*l*. in the following year.

One other striking event in the history of the college must be noted. In 1877 a memorial, largely supported, was sent to the Privy Council praying for a charter to convert Owens College into the University of Manchester. This was followed by a memorial from the Yorkshire College asking that a charter should not be given to Owens College, but "to a new Corporation, with powers to incorporate the Owens College and such other institutions as may now or hereafter be able to fulfill the conditions of incorporation." This petition proved successful, and the Victoria University received its charter in 1880.



FIRST FLOOR PLAN

FIG. 2.

Owens College became by the terms of the charter

the first college of the University; in 1884 University College, Liverpool, founded in 1881, and in 1887 the Yorkshire College, Leeds, founded 1874, were associated with it as constituent colleges of the University. By its charter women are admitted to all the degrees of the Victoria University. They were first admitted to lectures of the Owens College in 1883, and of the 1002 registered students in 1899—all of whom, however, are not students of the University—126 were women.

Such is, in brief, the history of the first of the University Colleges of the country. Space forbids any attempt at a description of all the present buildings, or of the interior organisation of the college and its relation to the University; much information on these points may be obtained from the book, and the plan and illustrations, which have been prepared with great care and skill, give an admirable idea of the buildings. Among these the most recent are the Christie Library and the physical laboratory, opened by Lord Rayleigh in June last. The Manchester Museum, however, must have a special mention. The nucleus of the collection consists of the specimens belonging to the Manchester Natural History Society and the Manchester Geological Society, transferred to the college with some endowments in 1872. The college is bound to maintain the collections and give the public access to them, free of charge, on certain days. The public lectures, which have become well recognised institutions, are also delivered by the staff and others.

The collections are now housed in splendid buildings and maintained at a total cost of 2700*l.* per annum, of which some 900*l.* is provided by endowment while 400*l.* is a grant from the City Council.

Enough, perhaps, has been said to indicate the magnitude and importance of the work performed for the country by the Owens College; if more proof is needed it can easily be supplied from the volume under review. The ninety pages covered by the record of original publications contain the names of many who have made their mark in literature and science, together with the titles of numerous papers universally recognised as of the highest merit. The authorities of the college did good service to the cause of university education in the country when they prepared a volume such as this for exhibition at Paris. R. T. G.

LORD LILFORD'S LIFE.[1]

THE scientific aspect of the late Lord Lilford's career is, we are informed in the preface to the present volume, to be written by another hand. The task of his sister has been, in the main, to set before the world the character and every-day life of her brother. And a noble theme, admirably carried out, the author has had before her. To a man fond of field sports and an enthusiastic observer of nature, scarcely any more terrible affliction, save loss of sight, can be conceived than to be stricken down in the prime of life by a malady which rendered him for the rest of his days a helpless cripple dependent for every want upon the attention of others. And yet how nobly and how patiently was this affliction borne by the subject of this pathetic memoir! Of course, every alleviation that money could purchase or affection suggest was at his command, but even so the trial of existence under such distressing circumstances must have been a heavy burden. How much was done by the late peer to advance the science he loved so well, and to ameliorate the lot of his fellow sufferers in humbler walks of life, those who knew him intimately can alone tell. The story of such a life is a lesson and a bright example to us all, and it should thus attract many readers besides personal friends and those interested in ornithology.

But in a journal like NATURE, attention must be directed to scientific rather than to moral attributes, even in a memoir which purports to treat chiefly of the latter. From his earliest days Lord Lilford appears to have displayed a remarkable fondness for animals, and throughout his life the observation of their habits seems to have afforded him the most intense delight. To those who are not endued with this love of living creatures it is difficult to realise how strong is its development in others. Although in earlier days a keen sportsman, Lord Lilford states he experienced more delight in watching the movements of wild birds than in shooting them; and in the collection at Lilford it was his aim that the feathered captives should enjoy as much liberty and space as was compatible with deprivation of complete freedom. The sight of a captive eagle moping in a cramped cage, with draggled feathers and unclean surroundings, was absolutely hateful to his sensitive nature; and the collection of eagles and other birds of prey at Lilford afforded an example, as regards mode of treatment, to the menageries of the world. But cranes were the birds which formed the great specialité of the Lilford collection, and only a

FIG. 1.—A bittern in the crouching attitude (from "Lord Lilford's Life").

[1] "Lord Lilford, Thomas Littleton, Fourth Baron." A Memoir by his sister, with an Introduction by the Bishop of London. Pp. xxiii + 290. (London: Smith, Elder and Co., 1900.) Price 10*s.* 6*d.*

bird lover can fully realise the joy of the owner at the completion of the series, in 1894, by the arrival of a specimen of the wattled species.

Lord Lilford, in his published letters, constantly deprecates his own claims to be regarded as a scientific ornithologist; but, altogether apart from his beautiful work on British birds, we venture to think that the work of the field-naturalist, which he did so much to advance, is at least as important as that of the systematist. Not that the late peer was in any way out of sympathy with the latter line of research; quite the contrary, as is demonstrated by the letter from Mr. O. Thomas, referring to his generous aid in assisting to complete the collection of European mammals in the British Museum with a view to a future exhaustive work on the subject. In addition to his energetic efforts on behalf of bird protection (including the prohibition of indiscriminate egg-collecting), Lord Lilford displayed especial interest in the fauna of Spain—an interest which has been happily commemorated by the name assigned by Mr. de Winton to the Spanish hare, which has been recently found entitled to specific distinction.

In the main the letters which the author of the memoir has selected for publication help in forming a true estimate of the character of their writer; but, in our opinion, some of those to artists and taxidermists referring to minute details in their works might advantageously have been omitted. One of the most interesting portions of the volume is the concluding chapter, which is made up by extracts from Lord Lilford's notes on his own collection of living birds and other animals. And the interest of this is much enhanced by the beautiful sketches of birds in the collection from the talented pencil of Mr. Thorburn, one of which we are enabled to reproduce. One of the objects dear to Lord Lilford's heart was to obtain portraits of birds in their natural and characteristic attitudes, and thus to improve the system of mounting specimens in museums, where it was formerly the exception to find a species in anything approaching a natural pose.

Apart from the noble example of his life to mankind in general, the loss to natural history of a man like Lord Lilford is one that will not easily be replaced, as, unfortunately, but few of those endowed with wealth and leisure display any inclination to follow in his footsteps.

R. L.

PROF. J. G. AGARDH.

JACOB GEORG AGARDH, the great Swedish phycologist, was born at Lund on December 13, 1813. His father was the celebrated Dr. Carl Adolf Agardh, professor at Lund University, and afterwards bishop in the diocese of Karlstad. The elder Agardh was the author of the "Synopsis Algarum Scandinaviæ," the "Systema Algarum" and the "Species Algarum," which laid the foundation for the brilliant work accomplished by his son.

Jacob Agardh entered as a student in the University of Lund in the year 1826, became doctor of philosophy in 1832, docent in 1834 and demonstrator of botany in 1836. In 1847 he became extraordinary professor, and in 1854 he was made ordinary professor, which post he held till 1879, when he retired.

His first paper, on Pilularia, was published in 1833 and was followed by several others on botanical subjects, mainly systematic. In 1836 appeared his first paper on algæ, and from that time till shortly before his death he continued with unfailing activity to publish papers and books on marine botany. The greatest work of his life was the "Species, Genera et Ordines Algarum," in which he laid down for the first time the lines of a natural system of classification in algæ. The English phycologists, Greville and Harvey, had helped to pave the way for this monumental work, and the elder Agardh had prepared some of the ground in his "Species Algarum" already mentioned. Dr. Kützing in Germany had already begun, in 1845, his "Tabulæ Phycologicæ, but it remained for Jacob Agardh to bring into order the many genera of marine algæ which had been left untouched, and to divide up the whole group into series, orders and genera. It is difficult for a worker in these days to realise the chaos in which the whole subject of algæ was involved when Prof. Agardh began his great work. Records were scattered throughout botanical literature, and it is no marvel that a species was described more than once through ignorance of an already existing diagnosis. The "Species, Genera et Ordines" brought together all the hitherto described species and added many new ones. These were arranged according to a natural system, and their synonymy, literature and geographical distribution were appended. From that time all work on algæ was straightforward, and although in time this book of Prof. Agardh may be superseded, it will long remain the ground plan of systematic phycology. The first volume dealt only with Phæophyceæ, and was published in 1848. Four volumes on Florideæ followed, of which the last is a revision and enlargement of the first part. The Corallineæ were worked out by Prof. Areschoug and included in the third volume of the work. In the introduction to the last volume, published in 1876, the author states that he has treated of "the disposition and description of forms" rather than "of the organs which have been considered of the greatest importance"—the trichogyne and antheridia, and the functions of these organs. This statement is specially interesting in regard to the classification of Prof. Schmitz, which is now so largely followed. There the differences which form the groundwork of the classification consist in the various forms of development in the carpogonium after fertilisation has taken place, thus forming a system which, however correct scientifically, is wholly unpractical for systematic workers. (It is, however, only fair to add that in this respect the system was perhaps only left incomplete through the premature death of its author.) In Prof. Agardh's system the algæ are classified according to their mature form, and indeed, as is only natural, the whole of his earlier work makes more of macroscopic, or at least of the less minute characters, than is usual in these days. In some cases this led him into error, but, on the whole, it is interesting to see how much his work is confirmed in the main points by the investigations of later botanists working on different lines.

In 1872 there appeared the first part of "Till Algernes Systematik," which was published at intervals till 1890, and dealt at length with genera in all groups of algæ. The treatment of the genus Caulerpa has been alluded to by Mdme. Weber van Bosse in the dedication of her monograph of this genus, in which she declares Prof. Agardh to be the first to give a natural system to Caulerpa and to open the road for a special study of these algæ. These words apply to many another genus as well. In 1879 an important work, "Florideernes Morphologi," appeared, followed by "Species Sargassorum Australiæ" in 1889; and in 1892, when in his eightieth year, a new work was undertaken entitled "Analecta Algologica." Parts were issued at intervals, and, although it was supposed a few years ago that the aged botanist had finished his work, and that the "Analecta" had come to an end, he still continued writing, and even published a part so late as last year. The work of these years cannot be ranked so highly as that of his middle life; but nothing can ever detract from the brilliancy and lasting worth of his work in earlier years.

Prof. Agardh was referee to Kew for algæ, and many specimens in that herbarium bear their names in his handwriting. In later life he received much material

from Australia, where Miss Hussey and others collected for him. The herbarium of the late Mr. Bracebridge Wilson, which was bought by the British Museum in 1896, had been referred to Prof. Agardh, and some of his notes are found in Mr. Wilson's handwriting copied on the sheets.

Of the kindness of the late professor it is possible to speak from personal experience. He was always ready to help and advise any student of algæ; he would examine a plant sent to him and endeavour to identify it, and, when the circumstances warranted the risk, he would send his own valuable type-specimens for examination. Never did Prof. Agardh fail to give of his best, though from his position in the world of phycology requests must sometimes have been numerous, and leisure uncommon. So late as December of last year it was my privilege to receive from him on loan a type-specimen of one of his species of Siphoneæ, and for the first time there was in his letter a strong vein of anxiety concerning the alga, and an urgent request that it might be speedily and carefully returned. The whole letter showed most markedly the advance of age, and the evident relief when the alga reached him safely on its return was almost touching. Quite shortly afterwards came the news of his death on January 17 of this year.

His knowledge of English was excellent, and he wrote it well and idiomatically.

His herbarium was given by him some years ago to Lund University, the home of his own work and of his father before him.

Medals and honours came to him from all sides. He was member of the Vetenskaps Academy, honorary member ot the Göteborg Scientific and Literary Society, as well as of the Scientific Society of Upsala and the Agricultural Academy and Physiographical Society in Lund. In 1862 he was appointed to confer the degree of Ph.D. at Lund, in 1879, at the jubilee of the Copenhagen University, he received the honorary title of doctor of medicine, and in 1883 he became a "jubeldoktor" of philosophy. In 1893 he was decorated with the Grand Cross of the Nordstjern Order, in 1886 the Vetenskaps Academy presented him with the Letterstedt prize for original work, and in 1897 he received the gold medal of the Linnean Society. He was also knight of the Prussian Order Pour le Mérite.

As delegate for the University of Lund he attended the two last sessions of the Ecclesiastical Council, and after the change in the representation he was member for the town of Lund in the second Chamber from 1867-1869 and from 1870-1872. He was also member of the Mint Committee of 1872.

He married, in 1848, Margareta Helena Sofia Meck, who survives him; and he leaves two sons, one of whom continues the family tradition of being attached to the University of Lund. E. S. B.

PROF. ELISHA GRAY.

IT is with great regret that we learn of the death of Prof. Elisha Gray on January 21. Prof. Gray was born at Barnesville, Ohio, in 1835; he was apprenticed to a carpenter, and during the time of his apprenticeship he studied physical science. At the age of twenty-one he went to Oberlin College, where he worked for five years, and at which he afterwards became professor. Prof. Gray first turned his attention to electrical invention when at the age of about thirty; he then invented a self-adjusting telegraphic relay. This was soon followed by other inventions of telegraphic apparatus. In all he took out about fifty patents, mostly dealing with telegraphy and telephony; one of the latest of these, and one of the best known, was the telautograph, a telegraphic apparatus for transmitting handwriting to a distance. At the time of his death he was engaged in carrying out experiments on a method of marine signalling with electric bells by which the sounds could be transmitted several miles through the water. In the course of these experiments, we understand from an American contemporary, he caught a chill which caused his sudden death.

Prof. Gray's name will be perhaps best known and remembered in connection with the invention of the telephone. On February 14, 1876, he lodged a caveat with the American patent office for the invention of a telephone. On the same day, but a little later, Graham Bell lodged a caveat for his similar invention. Bell was, however, the first to perfect his instrument, and in consequence Gray yielded to him in the dispute as to priority which arose, and the matter was compromised by the purchase of both patents by the same company. In later years, in the course of legal cases which arose in connection with the Bell patents, disclosures were made by which Gray was led to believe that his caveat had been betrayed to Bell by one of the patent examiners. Whether this actually was true or not seems to be uncertain, but in any case Gray firmly believed in its truth, and his later years are said to have been embittered by the thought that he had been cheated out of the money and credit he deserved. In 1878 his work in connection with the telephone was recognised at the Paris Exhibition, and he was decorated with the Legion of Honour. In 1893 he was Chairman of the International Congress of Electricians at the World's Fair at Chicago. He was the author of a popular book on electricity, and also of several papers communicated to scientific societies.

THE INDIAN ENGINEERING COLLEGE, COOPERS HILL.

A DEPUTATION waited on Lord George Hamilton on Tuesday last with respect to the recent dismissals from Coopers Hill College, and in support of the following memorial, with 374 signatures attached, including the names of the principal leaders of science in the country. The deputation was introduced by Lord Kelvin, and there were present Lord Lister, Lord Rayleigh, Sir H. Roscoe, Prof. Armstrong, and Dr. G. J. Stoney, who spoke in relation to the question; Sir F. Bramwell, Sir F. Abel, Sir Norman Lockyer, Sir William Crookes, Prof. Carey Foster, Prof. Meldola, Prof. Le Neve Foster, Prof. Everett, Prof. Perry, Prof. Poynting, Dr. G. Johnston, and many others.

Memorial to the Right Honourable the Secretary of State for India.

The correspondence regarding Coopers Hill College which has been published in the *Times* of January 3, 1901, which includes Sir Horace Walpole's letter to Colonel Ottley of December 14, 1900, and Colonel Ottley's letter of December 17, 1900, has caused a painful shock to those engaged in higher education throughout the United Kingdom, and to all who are interested in the training of engineers.

This correspondence relates to the sudden and arbitrary dismissal of able and distinguished scientific teachers, who have been doing duty in the College for periods of from nine to thirty years, and the value of whose past services is at the same time officially recognised.

Such arbitrary dismissal is likely to affect adversely the cause of scientific teaching in the United Kingdom. It cannot fail to injure the future of the College. During the correspondence which has ensued it has become apparent that the teaching staff have no voice in the educational policy of the College, and are not consulted when any change in the curriculum is contemplated. We wish to draw the attention of the Secretary of State to this unsatisfactory state of affairs, which must militate against the success of the College as an educational centre.

The sudden dismissal is action of a kind which we were not prepared to expect in any institution under the control of the British Government; and we think that the seven members of

the staff who are required to retire at three months' notice are justified in asking for the inquiry into the working of the College, for which they have petitioned in their memorial of Dec. 27, 1900.

We therefore desire to express our hope that the Secretary of State for India will see his way to grant their request, and to suspend proceedings until an adequate inquiry by competent persons shall have been held.

Lord Kelvin, as reported in the *Times*, said he represented 374 signatures with respect to the seven dismissals from the Engineering College. He had received letters of apology from Sir Batty Tuke, who expressed the conviction that a great injustice had been done; from Sir Richard Jebb, who expressed the opinion that the dismissals were harsh and derogatory to science and deterrent to good men; from Col. Milward, from Prof. Oliver Lodge, who said the professors had been treated like pawns; Sir Douglas Fox wrote as an ex-governor of the college who had received no notice of this proposed "drastic change." Sir Douglas Fox said that certain changes had been suggested to the board of visitors, and among these the supersession of two out of the staff; but he was astonished to find seven men dismissed.

Lord George Hamilton said that all who were present signed the report. Sir D. Fox was wrong.

Lord Kelvin said he had read in the *Standard* that the board of visitors were unanimous. But the letter of November 2—the origin of the change—was founded on recommendations of the board of visitors at that date, and those recommendations did not propose that seven gentlemen should be dismissed. It was clear that the general public looked upon the board of visitors as the governing body, and in so doing were resting on a broken reed. The board appeared to have had little to do with the matter. The object of the memorial was threefold—(1) To protest earnestly in the public interest against the proposal for the sudden and arbitrary dismissal of seven out of fourteen of the staff of the college; (2) to call attention to the continued prosperity of the college and the need for reform in the curriculum; (3) to express a hope that the Secretary of State would countermand these changes, until adequate inquiry was made and they were shown to be necessary for the good of the college. Sir Horace Walpole rested the case on economy. Now the cost of the whole scientific staff was 7970*l.*, and the fees were 22,143*l.*, or about 36 per cent. of the receipts for tuition. When the number of students did not fall below 121 there was a surplus; and thus retrenchment could hardly be the real reason. The proposed change would effect a saving of 2750*l.*; and certainly economy at the expense of efficiency was a great mistake. The dismissal was sprung upon the threatened persons, and was certainly not creditable. One of them—an old pupil of his own—described it as a blow in the dark, and said he could not understand it. It might, his correspondent said, have been desirable to reduce the number, but it was inconceivable that the abolition of the professorships of chemistry and of physics and of the posts of demonstrator of physics and of instructor of physics should have been recommended by the board of visitors. The chemistry for the future, it appeared, was only to be such as should enable engineers to understand the statements of results of professed chemists. There was to be no electricity or magnetism. Did the authors of this scheme know anything of the requirements of engineering? Electrical engineering was still on the list. That was an applied science; and thus we had a British Government college, teaching the application but not the fundamental principles of a science. Was that worthy of this country? The public might fairly expect that the present staff would, at all events, continue to the end of the present year, as entering students could hardly be deprived of adequate teaching of the full curriculum of subjects. The Secretary of State himself had borne testimony to the excellence of the college—even so recently as last year. There might have been some falling off, but a high standard was kept up. There had, no doubt, been some complaints, and from India the telegraphy course was found fault with. But that course was not intended to be exhaustive, but was to be supplemented by other members of the staff. But there was no complaint about any candidate who entered the Public Works Department of India. In the telegraph department two gentlemen were admitted into the public service whom Coopers Hill refused to certify. He earnestly hoped the noble lord would let the existing prospectus be that of 1900, and that Colonel Ottley and his staff would contrive to work together and remove causes of mutual friction. Discipline, law and order were doubtless necessary, but they might be harshly enforced; and of these gentlemen there was no recorded complaint.

Lord Lister said there were two questions; one the manner of the dismissal, and the other the expediency of the changes in the curriculum. On the first he needed to add nothing to what Lord Kelvin had said. Such a step was a great discouragement to those who wished to follow a scientific career; such appointments were rare, and a man's lifework might be abruptly stopped by such treatment as was being accorded. In his own profession he had to lament the tendency of examining bodies to abolish or minimise scientific training.

Lord Rayleigh said that unless such educational posts under the Crown were reasonably secured, there would be great difficulty in getting good men. Of the men to be dismissed he had personal knowledge of some, and Prof. McLeod was a man of world-wide repute among chemists.

Sir Henry Roscoe was sure that Lord George Hamilton had acted for the best: but they were convinced that he was mistaken. The dismissal of these men without notice was subversive of the interests of science and prejudicial to the college itself.

Prof. H. E. Armstrong said that these gentlemen's colleagues felt the action of the Government to be a positive affront. None of the signatories to the memorial, he thought, objected to a careful revision of the subjects and methods of the college; but that was another matter. If the new teaching of chemistry was to be such as had been described, it would be better to drop the subject altogether. If our engineers of India had been competent chemists they would have been able to advise the indigo planters and prevent the transfer of a trade of three millions to German planters.

Dr. G. J. Stoney said the letter of appointment to Coopers Hill was that it was tenable so long as the work was satisfactory; but with the proviso of three months' notice, without cause assigned on either side. The substantive clause and the proviso ought to have been read together, and the proviso ought not to render the words of the clause nugatory. The proviso was only to prescribe the method of dismissal if the work was not efficiently done. The interpretation of the proviso acted upon by the authorities virtually overrode the words of the substantive clause.

Lord George Hamilton, in replying to the deputation, is reported by the *Standard* to have said that as soon as he received a memorial to which were attached such distinguished signatures he felt it his duty to take the first opportunity of meeting the gentlemen who had expressed such interest in the future well-being of Coopers Hill College. He was under the impression when he read the memorial that it was based entirely on certain suppositions, and the more he listened to the speeches the clearer was it to him that the great mass of the signatories had, under some misapprehension, attached their names to the memorial. He had the honour of seeing a number of gentlemen whose names were household words all over the world as investigators in original science, and who had made discoveries of the utmost benefit to mankind. He ventured to point out that the memorial as drawn up would reverse the process by which they had achieved fame. That fame had been attained by an investigation into the phenomena of facts, and this memorial asked for an inquiry, but every speaker had with the utmost confidence pronounced an opinion upon the subjects on which he asked for investigation. He did not in the least find fault with the signatories, who had been misled, nor could he attach any blame to himself. The Coopers Hill Staff had adopted a very unusual and inconvenient course. They had a perfect right to protest against any action which they thought prejudicial to their personal interest, and to press the India Office to reconsider the question, but they sent a memorial to himself, and before it was possible to consider it they at once embarked in a newspaper agitation, with letters written by the gentlemen themselves or by their friends. He wished to explain very fully the reasons for the action the India Office had taken, and then he would ask the deputation whether, when the facts had been brought before them, the India Office could have acted otherwise than they had done. He then gave a short history of the foundation of Coopers Hill. From the outset the College had been a financial failure, and it had placed a considerable burden upon the revenues of India, and until quite recently there was a considerable deficit

in the revenues of the College. In 1895, Mr. Fowler, his predecessor, appointed a Committee to inquire into the financial position of Coopers Hill, which unanimously reported that the teaching staff of Cooper's Hill was out of all proportion to the number of students they had to teach, but there was then no inquiry made into the efficiency of the education given. Shortly after he became Secretary of State for India he came in contact with various members of the board of visitors, and he was warned that the College was very far from being in a satisfactory state, either as regards teaching or discipline, and that the best thing would be to abolish the College altogether. He declined to do that, and thought they ought to try to improve the College before attempting to abolish it. Nine months after Colonel Ottley became president of the College he presented a report in accordance with the instructions of the India Office. The memorial asked for an inquiry by competent persons. The inference rather was that whatever inquiry had been made was inadequate and had not been made by competent persons. His lordship quoted the names of the gentlemen forming the board of visitors, and mentioned their various qualifications, adding that there had not been a change made in the College that had not had the unanimous approval of the gentlemen to whom he had referred. Those gentlemen had gone through every proposition made to them, and it seemed to him a little unreasonable on the part of Sir Douglas Fox to try to convey to the public what passed at a meeting at which he was not present. The report which Colonel Ottley made showed a very unsatisfactory state of affairs at the College, and he (Lord George) was sorry to have to publish it. It was self-evident that the state of things was such that they could not tolerate. The deputation had come to him because they believed that one-half of the teaching staff had been summarily dismissed. He was afraid, therefore, he must detain them by going through each particular case. The reasons were so self-evident in each particular instance that he thought they would all agree that the Council had no option but to do what they had done. His lordship then gave details of the proposed scheme of retrenchment, mentioning the names of Mr. Reilly, Mr. Hurst and Prof. McLeod, and the gratuities and pension granted them. He now came to the four displacements, which were the result of changes that were to take place in the teaching at Coopers Hill. He had no doubt it would surprise gentlemen to learn that though electrical engineering had made enormous progress in recent years, it was not an obligatory subject at the College, and was hardly taught at all. They proposed to make it a compulsory subject, and to bring in a gentleman of high attainments from outside, who would be assisted by the very best lecturers that could be obtained. These changes necessitated the retirement of Mr. Stocker and Mr. Shields, who would be compensated. The two cases which were left were probably the most important of any of the changes they proposed. Everybody who had looked into the teaching at the College was of opinion that the right course was to place the whole course of engineering in the hands of one professor, with a competent assistant, and that being so, they were bound to appoint to the post the most competent professor for the position. That gentleman was Dr. A. W. Brightmore, and his appointment necessitated the retirement of Mr. Hearson and Mr. Heath, to whom pensions have been granted. The upshot of the whole matter would be this—there would be an increase in the hours of work in class and lecture from twenty-six to thirty-two, that the standard of the entrance examination would be raised, electricity as a subject would be thoroughly taught, outside examiners would be appointed, and the whole course at Coopers Hill would be brought, as far as practicable, into accord with modern engineering requirements. He had stated exactly the reasons and courses which had induced them to take the action they had done, and he thought they would see it was an impossibility for them to reopen the subject, or have a fresh inquiry. The noble lord went on to say: I often wonder how it comes to pass that when we spend so much money on our educational system, which in every branch is the most expensive in Europe, that we attain such unsatisfactory results. In every newspaper devoted to education in recent years there have been complaints by parents and others, pointing out the necessity of improvements if we are to hold our own. What is the main obstacle? What is the great impediment to all educational reform? I pass to a subject on which we shall all be in harmony—the system of education prevalent in our public schools. I read the other day an instructing report drawn up by a gentleman who had thoroughly investigated the system of teaching in force at the preparatory schools for the great public schools, and this was his comment:—"That in these preparatory schools the curriculum in force for boys of from twelve to thirteen is as follows: Hours per week: Eleven for Latin, five for Greek, three-quarters of an hour for English, two for history and geography, three for French, and six for mathematics," and he goes on to say that "this course of study is obviously faulty, though the fault is not with the preparatory schoolmasters, who are quite alive to the need of reform, and prepared to admit it when the public schools, which in this country depend upon the Universities, will allow them to do it." Why will not the Universities and public schools allow this ancient and antiquated system to be changed? Because the personal interests of those who teach classics stand in the way, and if you come to me, then, in the interests of scientific teaching for the future, are you not rather emphasising and accentuating the difficulty that must always face educational reform if the personal interests of those who teach are to be predominant over every other consideration? And there is another consideration which I think will come home to you—that no college is worth maintaining unless discipline and subordination can be infused into the students. I think it is very unfortunate that these gentlemen began to agitate in the way they did. The result has been that the students of the Coopers Hill College have begun to write to the newspapers, and I know of one very improper letter that was repudiated by the older students. I am most anxious to treat all the gentlemen at Coopers Hill College with the utmost consideration, but I am quite determined—and in that I express the unanimous opinion of the Council—that, so long as we are responsible for Coopers Hill College, we are determined to maintain discipline and subordination there. I should be exceedingly sorry if you went away with the impression that we had been harsh or discourteous or arbitrary towards the gentlemen who are to be dismissed; but we entered into a contract which necessitated our giving them notice if we wanted to dispense with their services. We are compelled to give them notice, and I do not see how we could have acted otherwise. I hope always to treat all gentlemen of scientific attainments with the utmost consideration, and to pay all attention to their wants; but it must be self-evident to everybody who dissociates himself from the subject under discussion, that the Government cannot for a moment admit that any gentleman who happens to be engaged in scientific teaching is to have such vested interest in the permanence of the post he holds that he is to hold it regardless of the terms or conditions of the engagement into which he has entered. Such a position is an impossible one, and, therefore, I cannot hold out to you any hope of going back on the decision which has been conveyed to these gentlemen. What we did we did deliberately, and after the fullest examination, and after we had availed ourselves of the advice of the best authorities at our disposal. Any suggestions that may be made by the gentlemen before me with regard to improving the curriculum and time-table at Coopers Hill or enabling the president of the College and the board of visitors to establish harmonious relations with the teaching staff will receive our most careful consideration. But we cannot undo what we have done, and, therefore, though the statements I have made will not be satisfactory to you all, I cannot help thanking you for the interest you have taken in Coopers Hill College, and I hope that if ever it becomes again the subject of discussion between us, I shall be able to show that the changes which we have made will result in improving the utility of the College and bringing it fully up to modern requirements.

Lord Kelvin thanked the noble lord for his courtesy in receiving the deputation, but expressed disappointment at the nature of his reply.

The deputation then withdrew.

NOTES.

PROF. J. A. EWING, F.R.S., has been elected a member of the Athenæum Club under the provisions of the rule which permits of the election of persons "of distinguished eminence in science, literature, the arts or for public services."

THE French Association for the Advancement of Science will hold its annual meeting this year at Ajaccio in Corsica, probably about the middle of September, under the presidency of Dr. Hamy.

WE deeply regret to see the announcement that Prof. Max von Pettenkofer, of Munich, distinguished for his work in hygiene and metabolism, shot himself on Sunday in a fit of depression. He was eighty-three years of age.

THE Institution of Naval Architects has awarded a gold medal to Prof. G. H. Bryan, F.R.S., for his paper on "Bilge Keels," read last year, and printed in abstract in NATURE of June 11, 1900 (vol. lxii. p. 186).

WE learn through the *Lancet* that a disastrous fire has occurred at the Pathological Institute in Berlin, and that the most valuable portion of Prof. Virchow's private museum has been destroyed. The loss of the anthropological collection made in the Philippine Islands by Prof. Jagor is especially regretted.

AT the annual general meeting of the Royal Astronomical Society on Friday last, it was decided by a large majority to hold future meetings at five o'clock instead of eight o'clock as hitherto. Dr. J. W. L. Glaisher, F.R.S., was elected president of the Society. Mr. Choate, the American Ambassador, was present at the meeting, and received the gold medal awarded to Prof. E. C. Pickering.

THE Brussels Academy of Sciences has awarded a gold medal, of the value of six hundred francs, to M. F. Swarts, for a memoir on the subject of carbonates of an element the compounds of which are little known. A similar award has been made to Prof. J. Massart, for a memoir on the nucleus of Schizophytes, and the Edouard Mailey prize of one thousand francs, for assistance in the extension of the knowledge of astronomy in Belgium, has been awarded to M. F. Jacobs, the founder of the Société Belge d'Astronomie.

A COMMUNICATION from Prof. A. Newton, F.R.S., relating to some bones of the crane found in excavating the Lynn Docks in the year 1867 or 1868, and now in the Gunn collection in the Castle Museum, was read at the last meeting of the Norfolk and Norwich Naturalists' Society. Prof. Newton gave some interesting information as to the remains of this bird which have been found in the peat of the Fen district, and mentioned other bones in the collections at Cambridge. Mr. Southwell read a paper on the crane in East Anglia, giving a summary of what is known from old authors with regard to the bird as a resident in the Fens, and tracing, as far as he was able, its extinction as an inhabitant. The crane now only visits Norfolk on very rare occasions, at the time of its periodic migrations, the last occurrence being in 1898, when four of these birds visited the neighbourhood of Cley and Runton.

A DEVELOPMENT of Mr. Marconi's system of wireless telegraphy was announced by Prof. J. A. Fleming, F.R.S., on Tuesday, in the course of an address to the members of the Liverpool Chamber of Commerce. Mr. Marconi's private work is carried on chiefly between stations at St. Catherine's, Isle of Wight, and Poole, in Hampshire. The line joining these stations is crossed by the Admiralty line between Portsmouth and Portland, but Mr. Marconi has been able to send and receive two messages simultaneously between his stations without in the least interfering with the Admiralty tests. He has also established a station at the Lizard, in Cornwall, which is 200 miles over sea in a direct line from St. Catherine's. Prof. Fleming said he had Mr. Marconi's permission to announce in public for the first time the result of the latest experiments. Setting up his improved apparatus and a mast 160 feet high, Mr. Marconi accomplished the astonishing feat of sending wireless messages between those two places on the first day of the reign of King Edward VII. Since then Mr. Marconi has established perfect communication without wires between the Lizard and St. Catharine's in both directions, and he can now receive two or more messages at once at each place.

TO give men of science and others the opportunity of visiting lands and places of particular interest, a number of cruises have been made in connection with our contemporary, the *Revue générale des Sciences*. The eleventh excursion will be to Sicily, Naples, Pompeii, Salerno, the ruins of ancient Paestum, and neighbouring places, at Easter, the party leaving Marseilles on March 31 and returning on April 16. The scientific guides of the party will be MM. G. Perrot and E. Bertaux, and at each place other distinguished men specially familiar with the objects, buildings, monuments and natural phenomena of interest will cooperate with them. The object of these excursions is more the study of lands and peoples, ancient and modern civilisation, scientific institutions and objects of archæological importance, than casual sight-seeing, and every effort is made to enable the members of each party to derive the fullest advantage from the visits. A programme of the Easter arrangements can be obtained from M. Louis Olivier, *Revue générale des Sciences*, 22, rue du Général-Foy, Paris.

THE accompanying illustration shows the arms recentl granted to the University of Birmingham. The two-headed lion is taken from the arms borne by Sir Josiah Mason, the founder of Mason College, now absorbed in the University, and the mermaid was his crest. The University, having no helmet, needs no crest. Following the usual university pre-

cedent, the motto is placed on an open book, and not on a ribbon below the shield. The arms are thus described in the grant:—Per Chevron the Chief per pale Gules and Azure in dexter a Lion rampant with two heads in sinister, a Mermaid holding in the dexter hand a Mirror and in the sinister a Comb Or the base Sable charged with an open book proper with two buckles and straps and edges of the third inscribed "PER ARDUA AD ALTA" of the fourth.

A REUTER correspondent at Cairo reports that Sir John Aird and Sir Benjamin Baker have completed their visit of inspection to the great engineering works at Assuan, where the immense dam to hold up the waters of the Nile is being constructed. The total extent of the dam is one mile and a quarter, of which one mile and an eighth of the foundation is finished. Temporary dams enabling the remaining section to be put in are now carried across the channel. The dam is pierced with 180 openings, about 23 feet high and 7 feet wide, which openings are controlled by steel sluices. The work for the latter is now well advanced. The discharge through these sluices at high Nile may reach 15,000 tons of water per second. The navigation channel and chain of locks are equally advanced with the dam itself, and the lock gates will also be in course of construction in about three

months. Unless anything unforeseen occurs the reservoirs will be in operation for the Nile flood of 1903. At Assiut the great regulating dam across the Nile approaches completion, the foundations being practically all in position, leaving a portion of the superstructure to be completed. The sluice openings here number 119, all 16 feet wide. This dam is somewhat similar in principle to the well-known barrage near Cairo, but the details of construction are entirely different, as the foundations are guarded against undermining by a complete line of cast iron and steel-piling above and below the work. The barrage itself is constructed of masonry instead of brickwork as at the old barrage. Although the Assiut barrage is overshadowed by the greater magnitude of the Assuan dam, it will, doubtless, rank second as the monumental work of Egypt.

WE have received from the Government Astronomer of Western Australia the meteorological report of the observations made at the Perth Observatory and other places in that Colony during the year 1899. Observations have been made since 1876 in the botanical gardens at Perth, and are still continued; for practical purposes these are very valuable, but since the year 1897 much more complete and trustworthy observations have been made at the new observatory. Most of the outlying stations have been inspected, and the observations now appear to be taken with much more care and regularity than in former years. Owing to the absence of any well-defined natural features, the Colony has been subdivided into one-degree squares, and the rainfall values of each square are shown very clearly in monthly and yearly maps. Other maps show, equally clearly, the mean monthly barometer and temperature, and the mean maximum day and minimum night temperature by the usual method of isobars and isotherms. A set of four platinum resistance thermometers has been sunk in the earth at Perth, and appear to give very satisfactory results. Morning and evening weather forecasts are issued, and have been remarkably correct, the amount of complete success reaching 82 and 89 per cent. respectively.

THE Palæontographical Society announces that monographs on the following groups of fossils are in course of preparation, and will be published by the Society: the Carboniferous Lepidodendra, by Dr. D. H. Scott; the Cycadeæ, by Mr. A. C. Seward; the Graptolites, by Prof. Lapworth, assisted by Miss Elles and Miss Wood; the Fishes of the Chalk, by Dr. A. S. Woodward; the Reptilia of the Oxford Clay, by Dr. C. W. Andrews; and the Cave Hyæna, by Mr. S. H. Reynolds. The volume issued by the Society for 1900 contains the Cretaceous Lamellibranchs, by Mr. H. Woods; the Carboniferous Lamellibranchs, by Dr. W. Hind; and the Carboniferous Cephalopods of Ireland, by Dr. A. H. Foord.

MR. HUGH J. L. BEADNELL, of the Egyptian Geological Survey, has published a brief account of the Eocene and Cretaceous series in the Libyan Desert and Nile Valley (*Geological Magazine*, January 1901). He has also expressed his opinion that the Nile Valley in Egypt, hemmed in as it is by lofty cliffs, was in the main brought about by faulting and disturbance in Lower Pliocene times. After the deposition of the Pliocene strata a gradual elevation led to the final retreat of the sea, and the valley then became the site of a series of freshwater lakes. In later Pleistocene times the then youthful Nile commenced its career by carving out a channel in the valley deposits, before, owing to changed conditions, it began depositing layer upon layer of Nile mud.

THE pre-Cambrian igneous rocks of the Fox River Valley, Wisconsin, are described by Dr. Samuel Weidman (Wisconsin Geol. and Nat. Hist. Soc., *Bulletin* 3 of Scient. Ser. No. 2). Three areas of these rocks are noted, and they represent various phases from old volcanic flows to masses of deep-seated origin. In the area of the Utley meta-rhyolite, metamorphism has taken place under static conditions, no cleavage is developed, and the alteration has been produced through chemical change without the aid of mechanical deformation. On the other hand, the Berlin rhyolite-gneiss has been subjected to extreme deformation, the original rhyolite being mashed into a gneiss; while the metamorphism of the Wanshara granite has been in part static and in part mechanical, cleavage has been developed and granulation of the quartz has taken place to some extent.

A FLORA of Staffordshire, by Mr. J. E. Bagnall, is being issued as a monthly supplement to the *Journal of Botany*.

THE Report on the Botanic Gardens and Domains, New South Wales, for the year 1899, gives an account of the new herbarium and museum buildings which were erected during that year. The director undertook no less than thirteen botanical explorations during the year, including one of Mount Kosciusco. The botanical results of these expeditions have been published in the *Agricultural Gazette of New South Wales* or elsewhere.

THE importance of variations in the osmotic pressure to the phenomena of vegetable life is illustrated in a reprint from the *Botanical Gazette*, by Mr. B. E. Livingston, entitled "On the nature of the stimulus which causes the change in form in polymorphic green Algæ." A series of experiments on a species of Stigeoclonium led him to the conclusion that these changes in form were due to variations in the concentration of the nutritive medium (Knop's solution), and not in any way to changes in its chemical composition.

AN important contribution to our knowledge of the flora of North America is issued by the U.S. Department of Agriculture (division of botany), as vol. vii. No. 1 of *Contributions from the U.S. National Herbarium*. It consists of a monograph of the North American Umbelliferæ by Profs. John M. Coulter and J. N. Rose. It enumerates and describes 62 native genera and 332 native species, besides introduced genera and species, the highest previous publication having been 52 native genera and 217 native species. The monograph is illustrated by a number of excellent wood-cuts representing either the general habit or the characteristics of the fruit of the species.

A BILATERAL division in the parietal bones of monkeys, according to a paper by Dr. Aleš Hrdlička in the *Bulletin* of the American Museum for December 31, seems to be a rare feature.

THE October issue of the *Bulletin* of the New Mexico College of Agriculture and Mechanic Arts is devoted to a series of observations and notes on the injurious insects of the country, by Prof. T. D. A. Cockerell.

DR. W. F. PURCELL contributes an important paper on the anatomy of *Opisthopatus cinetipes* to the *Annals* of the South African Museum (vol. ii. part 4). This arthropod, we may remind our readers, is a near ally of the more familiar Peripatus. The author is of opinion that the members of the group met with in Africa may be classified as follows:—(1) Peripatopsis, South Africa; (2) Opisthopatus, South Africa; (3) Peripatus, America, Africa, and possibly India. The distribution of the last-named, in connection with prevalent ideas as to the relationship of the South American and African faunas, is significant.

MR. J. D. E. HOLMES, superintendent of the Civil Veterinary Department, calls attention, in *Bulletin* No. 42 of the Department of Agriculture, Madras, to native beliefs connected with "hair-marks" on horses and cattle. These hair-marks, it appears, are formed by the changes in the direction of the hair on certain parts of the body, and, according to their shape, are denominated a crown, ridge, or feather-mark. Throughout India, but more especially in Madras, the value of a horse or an ox in native estimation depends almost entirely on the presence and situation of

certain of these hair-marks. According to native ideas, the old maxim that "a good horse cannot be a bad colour" does not hold good, white, dun, grey, piebald and skewbald animals being much more highly esteemed than those of other colours. A white bullock, again, is held to be of little value, while a black one is regarded as vicious.

SEVERAL popular scientific articles appear in the February number of *Pearson's Magazine*. Mr. R. S. Baker gives a description of some of Sir John Murray's work in oceanography, this being the first of a series on the science of the sea. Mr. Alder Anderson describes Russian Imperial forestry; Mr. T. E. James writes about the remarkable Crater Lake, Oregon; and Mr. T. Morton corrects some mistakes about rainbows in pictures, illustrating his contribution with several good photographs of rainbows. In *Good Words*, Miss G. Bacon describes the Yerkes Observatory; and there are also articles on an ascent of Mount Rainier—the highest mountain in the United States outside Alaska—the effect of light of various wave-lengths upon the growth of plants, the Purbeck marbles, and Miss Mary Kingsley.

IN an address recently delivered to the Chemical Society of the Goldsmiths' Institute, Dr. Julius Lewkowitsch dealt with "The Profession of an Industrial Chemist." The views of Dr. Lewkowitsch, who has had a long experience of manufacturing chemistry both in Germany and in this country, are entitled to very careful attention. He is able to recall the days when in Germany the chemical manufacturer was chiefly a merchant who thought he was marching with the times when he took into his works a young man to act as a testing machine and to become, later on, when he had shaken off the last remnants of chemical knowledge, assistant works manager. Dr. Lewkowitsch points out how entirely this condition of things, which is still prevalent in England, has changed in Germany. His main contention is that that the training which is most effective is that which is most liberal and educationally thorough. He has no grudge against the classics; on the contrary he extols their educational value when properly taught, and he is more solicitous that the school teaching of science should develop the logical faculty than that it should impart a fund of specialised knowledge. In the University period he would have a broad, thorough and unbiased study of chemistry and allied sciences ending, where possible, with some training in the special methods of technological laboratories. He concludes with a very graphic and complete account of the circumstances with which the chemist, so far trained, will have to contend in the works and the conditions necessary for his becoming the scientific master of his surroundings. Dr. Lewkowitsch's address combines high educational ideals with keen appreciation of practical requirements, and it deserves a wide circulation among those who are concerned directly or indirectly with chemical industries.

THE additions to the Zoological Society's Gardens during the past week include a Red-faced Ouakari (*Ouacaria rubicunda*) from the Upper Amazons, presented by Mr. Alfred Hutchinson; a Long-eared Bat (*Plecotus auritus*), a Common Bat (*Vesperugo pipistrellus*), British, presented by Mr. Louis Grundel; a Feline Dourocouli (*Nyctipithecus vociferans*) from South Brazil, a Yellowish Capuchin (*Cebus flavescens*) from South America, two Sharp-tailed Conures (*Conurus acuticauda*) from Paraguay, a Common Waxbill (*Estrelda cinerea*) from West Africa, seventeen Blue-tongued Lizards (*Tiliqua scincoides*) from Australia, deposited; a Sœmmerring's Pheasant (*Phasianus soemmerringi*) from Japan, an Elliot's Pheasant (*Phasianus ellioti*), two Amherst Pheasants (*Thaumalea amherstiae*) from China, a Black-backed Kaleege (*Euplocamus melanotus*) from Sikkim, purchased.

OUR ASTRONOMICAL COLUMN.

VARIABILITY OF EROS.—A circular from the Centralstelle at Kiel calls attention to an important notice from Dr. E. von Oppolzer respecting the planet Eros. He says that Eros shows a variation of brightness of about one magnitude, the change taking place in a few fours. It is in the highest degree desirable that, so far as possible, numerous estimations with neighbouring stars should be made in the course of each night.

CATALOGUE OF PRINCIPAL STARS IN COMA BERENICES CLUSTER.—The sixteenth issue of *Contributions from the Observatory of Columbia University*, New York, contains the discussion and reductions by Mr. W. C. Kretz of a series of measures of this cluster, from photographs obtained by Dr. Rutherford with his 13-inch refractor during 1870–76. The eleven standard stars adopted were reduced from the records of thirty-five catalogues, extending from that of Bradley in 1755 to the Greenwich results, 1887–94. The method of reduction is given in detail with tables of data for determining final positions, concluding with a list of twenty-four stars showing corrected coordinates and proper motions.

UNITED STATES NAVAL OBSERVATORY.—The report of the superintendent of the Naval Observatory at Washington deals with the progress of work during the fiscal year ending June 30, 1900. All the instruments have been in use on every clear night and day.

The 26-inch equatorial has been devoted to observations of difficult double stars, satellites of planets, and a long series of investigations on the use of ocular colour screens for planetary and double star measurements. The double floor, mentioned in a previous report, has undoubtedly improved the working conditions in partly eliminating the variable air currents in the dome. Certain markings have been observed on the disc of Neptune indicating a similarity to the belts of Jupiter.

Photographs of the sun have been taken with the photoheliograph of 40-feet focal length on every fine day, except in April and May, when it was dismounted for use during the total eclipse of the sun. For this eclipse an extensive programme, including spectroscopic, polariscopic and other items, was successfully carried out, the report of which will be ready shortly.

DOUBLE STAR MEASURES.—In the *Astronomische Nachrichten* (Bd. 154, Nos. 3680–1), Dr. Doberck gives a long series of measures of double stars obtained with the 14-inch refractor of the University Observatory, Copenhagen. Comparisons are discussed between the performance of short and long focus instruments with respect to the measurement of close doubles.

SCIENCE AT SHEFFIELD UNIVERSITY COLLEGE.

TWO addresses delivered at the University College of Sheffield on Thursday last, the occasion being the annual distribution of medals, prizes and certificates to successful students of the Technical Department, should be of service to science and technical education in the city. One was by Dr. H. C. Sorby, F.R.S., who during the greater part of the past fifty years has been occupied with scientific research. His remarks on the practical value of scientific theory admit of wide application, and the following report from the *Sheffield and Rotherham Independent* will be read with interest. A valuable address on technical and scientific education was also given by Alderman W. E. Clegg, who in the course of his remarks indicated three directions in which future efforts should be devoted in order to maintain our position in the industrial world; they are:—

(1) Greater energy and enterprise on the part of our manufacturers in utilising to the utmost existing markets, finding fresh ones, seizing every opportunity which presents itself to develop our increasing output and a greater adaptability and suitability of our goods to the requirements of our customers. (2) A closer union and real sympathy between employers and employed, each realising that the interests of the one are bound up in the interests of the other. (3) Greater interest and appreciation of the advantages of a technical and scientific education, and in connection with this all possible facilities should be given to men and boys to enable them to learn the science—the why and wherefore of the particular work they are engaged in—so that they can take an intelligent interest in what they are doing and what they have to do.

Dr. Sorby spoke as follows :—

What he proposed that evening was to say something with regard to the interdependence of the different branches of knowledge. He would speak only of physical science, and he would confine his remarks to what bore directly on the Technical School. He was very sorry to say that as things were at present many looked upon the University College as quite a distinct thing from the Technical School. Unfortunately there were two buildings, and he thought that had something to do with the idea. But he did hope that before long there would not be two buildings. He hoped they would succeed in erecting a University College that would include all the branches, and he would very much like to see written over the door: "Scientia una et indivisa."

He took it that he might assume that knowledge such as they were trying to teach in the University College might be divided into two divisions—what they might be pleased to call science, theoretical and practical. Now he maintained that the division between theory and practice was perfectly evanescent. It might be convenient to divide them, as it was convenient to divide yesterday and to-morrow; but when to-morrow came, to-morrow would not be to-morrow. It was the same with theory and practice in science. What was looked upon to-day as abstract theory, and of no practical use, would probably be to-morrow the foundation of some most important practical question which would revolutionise the whole world. He could not call it a feud, but the division of these two branches—theory and practice —was now non-existent. He was afraid that a good many people looked upon some branches of the subjects which were studied in the college as of not very much use, simply because they did not enable them to make puddings or construct anything else. He maintained that that was a very false view of the matter. Now, he had often heard in years gone by that theory was no good! What was wanted was good practical knowledge. In illustrating that idea, he would refer to a matter he recollected when we were carrying on the war in the Crimea. It was said that when the Russians built Sebastopol they furnished the labourers with wheelbarrows. The men had never seen a wheelbarrow before, and they filled them with earth and carried them on their backs. They could very well imagine some accomplished Russian officers pointing out the advantage of the wheelbarrow, and telling them how much labour might be saved by pushing the barrows instead of carrying them. Some of those labourers might have replied that they did not care a bit for what the officer said; what they really wanted was a good practical knowledge of how to carry the wheelbarrow on their backs. It was not so many years ago that one heard similar remarks to this in reference to a great many other subjects than wheelbarrows. He thought he might even say that in some cases pure theory was much more practical than practice.

There were cases where they could obtain a result with ease and accuracy by calculation, and if they attempted to do it by practice they would not do it so easily, and they would not do it with anything like accuracy. In such a case he held that theory, after all, was the much more practical of the two. He had been talking to Dr. Hicks about a subject for a lecture which he hoped to give from that desk in time to come, and he suggested as the title of that lecture, "The value of knowledge thought to be useless." There were no end of interesting illustrations to be found, and he was sure it would be a very good subject for a popular lecture. He could not help slightly trenching on that lecture because it had a lot to do with what he was trying to point out that evening. Some 2500 or 3000 years ago it was found that if you rubbed amber on cloth or anything of a similar nature it would attract little bits of paper. The Greek word for amber was "Electron." What would anybody have thought in those days if any one had said that if you only studied that peculiarity a little more you would be able to have tramcars with halfpenny fares? He need not describe what would have been the opinion of people in those days on that subject. Then again, the lodestone was called by a word which ultimately led to the word "magnetism." It was known that lodestone would attract bits of iron, and he believed it was Pliny who said that it had "such a great love for iron that it pulled pieces of iron to it." No doubt that idea and very little more than that notion existed for something like 1500 years. Then somebody found out that you could magnetise a needle, and that it would point to the north, and shipping was entirely revolutionised. Then again, Galvani, fortunately, was taken ill, and it was thought it would be a very good thing for him to have some frogs for dinner. When the cook placed the frogs' legs on the pewter plate on which they were served she noticed that they began to kick. She thought this very curious and drew Galvani's attention to it. The result was the discovery of Galvanism. These things were known for a very long time. He remembered the time before the principle of electro-plating was discovered. He recalled the man who discovered how to electro-plate with silver. They used to entertain themselves with making galvanic batteries and trying experiments. He remembered very well that his friend said, "Well, now, Sorby, I don't see any reason why we should not study these things, although people say that electricity is a thing that can never be of any use to anybody." What would anybody say if that remark were made to-day?

About thirty-six years ago he pointed out how very important was the investigation of the microscopical study of iron and steel. He read a paper at the British Association meeting at Bath, and his specimens were exhibited before the Royal Society. They were very much admired, and thought very pretty, but for twenty-three years nobody did anything; nobody took the slightest interest in the subject. Eventually the Iron and Steel Institute asked him to read a paper on the subject. He did so, and the result was that the study of the microscopic structure of iron and steel was now thought of great importance. One felt very pleased to think that things had moved so, because this microscopic investigation, which was so long dormant, was now employed in almost every civilised country, and he was very proud to think that the Sheffield Technical School was at the front so far as this subject was concerned. Prof. Arnold, whom he very greatly regretted was ill, was selected by the Admiralty to make an investigation into the structure of the steel shaft which failed on one of H.M.'s torpedo boats. Prof. Andrews was also an authority on the structure of steel rails, and he was often consulted in connection with railway accidents. He did not want to occupy too much time, but what he did wish to impress on his audience was this, that judging by the experience of years gone by there was nothing that you could discover that might not turn out to be of the greatest possible value. You could not say that it would, but you could not say that it would not. As an example, some few years ago a friend of his was examining under the microscope with a very high power the blood discs in the blood of frogs, and he discovered in these blood discs certain curious little things which were found to be very minute parasitic animals. If they had mentioned this to the man in the street he would have thought that it was a most absurd idea to pay much attention to a thing like that. But a further study of that subject had led to the knowledge of the real cause of a disease which in India killed annually about as many people as the whole of the population of England, and not only had they learned the cause of the disease, but there was every probability that they would succeed in putting a stop to it. The magnitude of the result was almost incomputable.

He could liken them all to a small colony on a big continent. They made a few roads and settled down. But if they were content with these few roads and never troubled themselves about the backland, how would they progress? Some other country would take the backland. What they wanted was to explore the unknown; to march to the top of some mountain and look down on the country never seen before by civilised eyes. They would then find valuable gold mines, coal, and all manner of things. If they were content with what they knew they would make no progress. They might hold their own, but he did not know whether they would do that. They should try to learn fresh things. His friend, Alderman Clegg, was about to distribute the prizes, which were all very well in their way, but he should like to see them win prizes for original research, to make discoveries and invent new industries, and conquer the trade of the world. They ought to develop the manufactures in this city in such a way that they might beat the Germans and the Americans, so that they might capture the trade of the whole world in their particular department. This electric railway in London—the only thing that was English about it was the tunnel. The only thing about that railway that was made in England was the tunnel. Everything else was American. It has even been said that it was surprising that the tunnel had not been sent to America to be made. But they did not want that sort of thing to go on, and in order to prevent it they must have no rivalry between theory and practice in science. He hoped they would be able on another occasion to meet in a building worthy of the town, and where all these different subjects would be correlated and united in one.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The degree of D.Sc. *honoris causa* has been conferred upon Dr. Oliver Lodge, and the degree of D.Litt. *honoris causa* upon Dr. F. J. Furnivall.

Mr. A. E. Boycott, of Oriel, has been elected to a senior demyship at Magdalen College to enable him to continue research in physiology and pathology.

CAMBRIDGE.—The collection of ethnological specimens formed in the Maldive Islands by Mr. J. Stanley Gardiner has been gratefully accepted by the University for the Museum of Ethnology.

Dr. A. W. Ward has been elected a member of the council of the Senate in the place of Bishop Ryle.

The following have been appointed electors to professorships:—Chemistry, Dr. A. Macalister; Plumian (astronomy), Dr. Ferrers; Anatomy, Prof. Newton; Botany, Prof. Bayley Balfour; Geology, Dr. R. D. Roberts; Jacksonian (natural philosophy), Dr. J. Larmor; Downing (medicine), Prof. Liveing; Mineralogy, Mr. J. E. Marr; Zoology, Mr. F. Darwin; Mechanism, Prof. Forsyth; Physiology, Dr. P. H. Pye-Smith; Surgery, Dr. D. MacAlister; Pathology, Prof. Allbutt; Agriculture, Dr. D. MacAlister.

Mt. Clinton T. Dent has been appointed an examiner in surgery in the place of Prof. Chiene.

The Isaac Newton Studentship in physical astronomy has been awarded to Mr. S. B. McLaren, of Trinity, third wrangler 1900.

The Adams Prize, for a memoir on electric waves, has been awarded to Mr. H. M. Macdonald, Fellow of Clare.

A Shuttleworth Scholarship in botany and comparative anatomy, of the value of 55*l*. a year for three years, will be filled up at Caius College in March. Candidates must be medical students of not less than eight terms' standing. Application is to be made to the senior tutor by March 1.

MR. E. J. GARWOOD has been appointed to the Yates Goldsmid chair of geology and mineralogy at University College, London, in succession to Prof. T. G. Bonney.

PROF H. LLOYD SNAPE has been appointed Director of Education to the Lancashire County Council. Formerly the directorship was limited to technical instruction, but the duties of the office have now been enlarged by the inclusion of all education other than elementary. For more than twelve years Dr. Snape has held the chair of chemistry at the University College of Aberystwith.

THE Manufacturers' Association of New York recently voted the sum of 2000 dollars for an industrial scholarship, including the cost of tuition for four years and incidental expenses. The purpose of the association in providing means for the industrial education of a young man of Greater New York is to encourage young men to qualify themselves for leadership in industrial pursuits. A committee has been appointed to arrange the details and to conduct the examination of the candidates.

A PAPER on the national organisation of agricultural education, contributed to the January number of the *Record* of Technical and Secondary Education, directs attention to the need for establishing instruction in agriculture upon a foundation of general science instead of regarding it as a special science with its own particular principles. Other articles in the *Record* deal with the organisation of individual secondary schools, local schemes of commercial education, education at the Paris Exhibition, horticultural education in Surrey, and school gardens.

THE following is a single week's statement of gifts to educational and scientific institutions in the United States. The announcements are from *Science*. John D. Archbold, of New York City, a vice-president of the Standard Oil Company, has given 400,000 dollars to the endowment fund of Syracuse University, on the condition that a like amount be raised among other friends of the institution; Mr. Andrew Carnegie has given 225,000 dollars to the Upper Iowa University, at Fayette, Ia., to be used preferably for a library, and 50,000 dollars to Aurora College, an Illinois institution; Augustana College at Rock Island, Ill., has received about 30,000 dollars from Messrs. E. C. and J. A. Ericsson, of Boone, Ia.; Mr. John D. Rockefeller has offered to give 15,000 dollars to Carson and Newman College, a Baptist institution in Tennessee, provided 50,000 dollars in addition be raised; Carleton College, at Northfield, Minn., has added 150,000 dollars to its permanent endowment fund, 50,000 dollars being the gift of Dr. D. K. Pearsons, and the remaining 100,000 dollars being raised from various sources.

A RETURN just issued by the Board of Education brings together a large amount of information as to the award of scholarships by County Councils in England. The scholarships are divided into three classes, viz. (1) junior scholarships intended to enable pupils in elementary schools to proceed to secondary schools; (2) intermediate scholarships, usually in continuation of junior scholarships, and tenable at secondary schools or technical colleges; (3) major or senior scholarships, comprising also those awarded in various special subjects. It appears from the Return that of the 4678 winners of junior scholarships specified, 4231 were in attendance at an elementary school, and 447 at a secondary or other school. Of the 519 winners of intermediate scholarships, 307 had previously held junior scholarships. The number of major scholarships awarded by the County Councils for general proficiency is 360, in addition to which 188 are awarded for agricultural subjects, 43 for horticultural subjects, and 150 for mining. These scholarships vary considerably in value, but generally they are of larger amount than those of the other classes, and some of them enable students to proceed to institutions of University rank. Particulars are given in the Return of all the County Council scholarships awarded in England in the three financial years ending on March 31, 1899, and also of the occupations of the parents of the winners of the scholarships. We see from this that the children of "professional and general" parents head the list of scholarship winners, and are followed by those of "clerks, agents and warehousemen," and then by children whose parents follow "building trades." It is evident, however, that the relative abilities of the children of parents of the different classes cannot be estimated from the positions of the children in the list without knowing the proportional numbers of each class in the population.

THOUGH there are few signs that the scheme for the establishment of a West of England University is making much headway, the speech by Sir Michael Foster at a meeting held at University College, Bristol, last week, and attended by many men of influence and means, should do something to bring about a *modus operandi* between the authorities of the educational institutions which would form part of the University. Sir Michael Foster remarked in the course of his speech:—"One idea in the establishment of Universities in the renaissance was that each University was a guild for the advancement of learning, and that had, with various changes, remained their object ever since. They were institutions for the advancement of learning; not only for the spreading of knowledge, but for the pushing forward of the known into the unknown. They had been through all time, with little variation, the great instruments of inquiry and research. A teaching body, whether it was called a college or a University, was a University in principle and in reality, and the whole of its actions were governed by the dominant principle of research, of inquiry into the unknown. Universities, to be real and true Universities, ought not to be merely machines for converting knowledge into pap and distributing it into open mouths. They ought to have some living feature and act as ferment upon the young minds, inducing changes, so that knowledge would grow up of itself in the mind when the mind was brought under its influence. It was this vital and living feature which was the dominant feature of a University, or a University College, or of the teaching of any University, by whatever name it was called. He would say to the citizens of Bristol that they had in their midst a body—whether they called it a University or a University College it was practically a University—the teachers of which he knew from personal knowledge to be truly inspired with the feeling of the necessity of inquiry into the unknown. He ventured to suggest that it was desirable such an institution, which must have great influence on all the intellectual progress, and therefore on the material advance of the West of England, ought to be founded, not upon the shifting sands of annual subscription, but upon the solid rock of permanent endowments." The citizens of Bristol should learn from this that they have in University College a nucleus of a modern University like that founded in Birmingham upon Mason College. Nothing should be permitted to delay the formation of an organic plan, to realise which an appeal for endowments can be made. The West of England ought to show that it can nurture education and science as well as the Midlands.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 7.—"On the Proteid Reaction of Adamkiewicz, with Contributions to the Chemistry of Glyoxylic Acid." By F. Gowland Hopkins, M.A., M.B., University Lecturer in Chemical Physiology, and Sydney W. Cole, B.A., Trinity College. (From the Physiological Laboratories, Cambridge.) Communicated by Dr. Langley, F.R.S.

The proteid reaction described by Adamkiewicz is not a furfurol reaction, but depends upon the presence of small quantities of an impurity in the acetic acid employed. Some specimens of acetic acid yield no reaction, and all may be deprived of chromogenic power by distillation.

The substance essential to the reaction is glyoxylic acid.

Small quantities of glyoxylic acid are produced during the oxidation of acetic acid by hydrogen peroxide in the presence of ferrous iron. Under the conditions used in this research, part of the glyoxylic acid thus formed is split up, yielding formaldehyde.

Glyoxylic acid is slowly formed when acetic acid stands in the air, and more rapidly in the presence of ferrous iron and under the influence of direct sunlight. Most specimens of acetic acid contain small amounts of glyoxylic acid as an admixture.

A dilute aqueous solution of glyoxylic acid, which may be readily prepared by the reduction of oxalic acid with sodium amalgam, forms an admirable test for proteids when used instead of acetic acid under the ordinary conditions of the Adamkiewicz test.

"Further Investigations on the Abnormal Outgrowths or Intumescences in *Hibiscus vitifolius*, Linn.: a Study in Experimental Plant Pathology." By Elizabeth Dale. Communicated by Prof. H. Marshall Ward, F.R.S.

The conclusions drawn from the experiments are that the outgrowths are formed in a moist atmosphere, provided that there is also adequate light and heat.

The immediate effect of the damp atmosphere is to check transpiration. This, in its turn, by blocking the tissues with water, disturbs the normal course of metabolism, and so leads (when the light and heat are sufficient) to changes in the metabolic activity of the plant, as is shown by the following facts:—

(1) The outgrowths only develop if transpiration is reduced.

(2) The outgrowths are chiefly formed on organs which are actively assimilating, *e.g.* under ordinary red or yellow glass; but only if transpiratory activity is lowered: they are not formed in the open.

(3) They only occur (*ceteris paribus*) in plants in which there is an accumulation of starch.

(4) They are formed under clear glass and under red and yellow glass, but not under blue or green glass, and in no case in darkness.

(5) Their formation is accompanied by the production of oil, which is not found in normal leaves.

(6) The presence of this oil suggests that events similar to those occurring in succulent plants are taking place, viz., reduced respiration and the development of osmotically active substances in excess.

(7) It is therefore probable that the intumescences are due to the local accumulation of osmotically active substances, produced under the abnormal conditions, viz., reduced transpiration and consequent lack of minerals, while carbohydrates are being developed in excess.

Physical Society, February 8.—Annual General Meeting. Mr. G. Griffith, Vice-president, in the chair. The report of the council was read and adopted. Prof. Willard Gibbs and Dr. Rudolph Koenig were elected to the two vacant honorary fellowships of the Society. The following officers and council were elected for the ensuing year:—President: Prof. S. P. Thompson. Vice-presidents (members who have filled the office of president): T. H. Blakesley, C. V. Boys, Prof. J. D. Everett and J. Walker. Secretaries: H. M. Elder and W. Watson. Foreign Secretary: Dr. R. T. Glazebrook. Treasurer: Prof. H. L. Callendar. Librarian: W. Watson. Other members of the Council: Prof. Armstrong, W. R. Cooper, G. Griffith, E. H. Griffiths, Dr. R. A. Lehfeldt, S. Lupton, Prof. Perry, Dr. Porter, W. A. Price and R. Threlfall.—Prof. S. P. Thompson then took the chair and delivered an address. In opening, the President gave in detail the various ways in which the aim of the Physical Society to promote the progress and study of physics has been accomplished during the twenty-six years of the Society's existence. Referring to the election of two honorary fellows, Prof. Thompson said they had added to their roll two men distinguished in very different walks of physics. Prof. Willard Gibbs is a United States mathematical physicist whose work in thermodynamics, elastic solid theory of light and other specialised subjects is of the highest order and is valued for its beauty and profundity. Dr. Rudolph Koenig, of Paris, is known as a maker of acoustical instruments—of perfect standard, tuning-forks in particular. He has, however, found time to extend the borders of acoustics, and to him we owe the manometric flames, the wave syren and other instruments of research. He has also published work on the facts about the combinations of pure tones. The President appealed to all teachers of physics in the country to make use of the Society and give it their active support. It was mainly in the interest of teachers and students that the Society undertook the publication of science abstracts. By means of the abstracts teachers have at hand the latest information on the subject, and can thus continually supplement their text-book knowledge. Every teacher, from time to time, devises new or improved modes of presenting his subject. At the Physical Society the Fellows always welcome contributions of this kind, even though there may be little of actual novelty in the principles so illustrated. The routine work and administrative duties of teachers, although hampering their usefulness to science and diminishing their fruitfulness, prevent their attention, without intermission, to one subject and produce a direction of thought over varions domains of physics which is to be welcomed rather than deplored. It has been the custom for Fellows of the Physical Society to bring models to illustrate physical principles. This practice of using models is regarded by our Continental brethren as a peculiarly English matter and one that shows a sort of mental constitution they do not quite understand. Models have become a part of our mental furniture. It never occurs to us that there is anything unusual in the habit. Faraday has used them in connection with the electrostatic field surrounding charged bodies. Lord Kelvin has made models to convey his ideas of elasticity, of the elastic solid theory of matter and of the constitution of matter itself. Maxwell's models of heterogeneous dielectrics and the mutual induction between two circuits are well known. These models are useful for teaching purposes and for enabling one to grasp that which in its nature is abstract by contemplating the representation of it or its analogue in the concrete. The French physicist cannot understand a complicated phenomenon until he has reduced it to a mathematical equation. The British physicist must construct a model which will produce mechanically the analogous operation. Both methods are right, but judging by their fruitfulness the method of Faraday has advantages over that of Poisson. Referring to the New Teaching University of London, the President said that now was the time for Fellows to offer suggestions for the teaching of physics.—An ordinary meeting of the Society was then held.—A paper on a mica echelon grating, by Prof. R. W. Wood, was read by Mr. Watson. This grating occupies a position midway between an ordinary grating and an echelon with thick plates. A number of sheets of mica were examined with the interferometer and one selected, over a considerable portion of which the fringes were straight and unbroken. This portion was marked off and cut up into rectangles. The mica was about 0·05 mm. thick, and the retardation of one of the rectangles was found to be fifty wave-lengths for sodium light. Nine of these rectangles were used to form the grating, and they were put in position under a microscope and cemented together at the edges with sealing wax. The grating space was 0·5 mm. The battery was mounted on a square of cardboard over a rectangular opening of the same size, a clear space 0·5 mm. wide being left to serve as the first grating line of zero retardation. The number of lines was therefore ten. The resolution of the sodium lines was beyond the power of the instrument, but the yellow mercury lines were easily separated. The distance between the lines was one-third of the distance between the spectra. For the sake of comparison, a grating of the same spacing and number of lines was ruled on a piece of smoked glass, and it was found that in the first order the grating was unable to separate the extreme red and blue ends of the spectrum. The Zeeman effect can be shown with an echelon made of four interferometer plates, the light being the green rays from a mercury tube. The Society then adjourned until February 22.

EDINBURGH.

Royal Society, January 21.—Lord Kelvin, President, in the chair.—The Chairman communicated a paper on one-dimensional illustrations of the kinetic theory of gases, in the course of which he referred to Waterston's doctrine of the partition of energy among molecules of different size, a doctrine which, although supported by Maxwell, Boltzmann and others, he believed to be not only not proved but not true. If the doctrine is found to fail in one particular case, its universality is disproved. By considering the impacts among a row of hard elastic spheres constrained to move to and fro in the same straight line, he had, by direct calculation of the effects of 300 successive collisions, found no tendency towards a state in which the average energy of *all* the masses was the same. When the time of impact was assumed to be infinitely short, so that no more than two spheres could be in contact at the same time, the calculation was simple enough; but the problem quite changed its character when the time of impact was taken as finite, so that three or more particles might be in contact at the same time. It was shown that impenetrability was not a necessary quality of molecules. If we follow Boscovich and regard them as centres of force, then two molecules might, on collision, simply pass through one another.—Dr. Knott read the first part of a paper on solar radiation and earth temperatures, in which a comparison was made between two sets of data, the one derived from Langley's well-known results, the other from a recent discussion by Dr. Buchan of temperature observations made at various depths in the eastern part of the Mediterranean Sea by the Austrian ship *Pola*. These seemed to indicate a daily see-saw of temperature in a stratum of surface water 50 metres thick. It was difficult to credit direct solar radiation with the power to penetrate so deep; but the difficulty was greatly increased when a simple calculation showed that the afternoon excess of temperature which was indicated meant an accumulation of 1460 units of heat under each square centimetre of surface during eight hours of daily sunshine. For, with Langley's value of the solar constant, it could be calculated that the *whole solar energy supplied* to each square centimetre of the earth's surface in the latitude of the Mediterranean during eight hours of the midsummer day did not exceed 750 units. This serious discrepancy seemed impossible of explanation if the general accuracy of both sets of data was assumed.—Dr. Thomas Muir communicated three papers, namely, note on pairs of consecutive integers, the sum of whose squares is an integral square; the differentiation of a continuant; and the Hessian of a general determinant. By direct calculation of the various elements, it was shown that the Hessian of the determinant D of the nth order had the value $\pm(n-1)D^{n(n-2)}$.

PARIS.

Academy of Sciences, February 4.—M. Fouqué in the chair.—Notice on M. Agardh, by M. Bornet.—On the origins of chemical combination. The allotropic states of silver, by M. Berthelot. The method employed is to measure the amount of heat developed by the various allotropic modifications of silver when dissolved in mercury. The five kinds of silver employed gave for 108 grams of the metal amounts of heat varying between 0·08 calorie and 2·03 calories. The values previously obtained for the heats of combination of silver with other elements depend, therefore, upon the state of the metal used, and hence require a correction.—Studies on the combinations of silver with mercury, by M. Berthelot.—On the isentropic stability of a fluid, by M. P. Duhem.—A simple apparatus for the application of the phototherapic method of Finsen, by MM. Lortet and Genoud. The rays from an arc lamp are concentrated by means of a globular flask, through which cold water is kept running. The greater part of the heat is absorbed by the water in the lens, and the apparatus has given good results in actual clinical practice.—Remark on the subject of a note by M. S. Kantor, by M. F. Enriques.—On pencils which are transformed on two sides into orthogonal pencils by the method of Laplace, by M. C. Guichard.—On the density of the zeros and the maximum modulus of a complete function, by M. Pierre Boutroux.—On the relation between the solar activity and the diurnal variation of the magnetic declination, by M. Alfred Angot. This problem has been attacked by applying the method of Fourier to the observations of Paris and Greenwich, the values for the constants obtained in the two cases agreeing very well.—On the borates of magnesium and the metals of the alkaline earths, by M. L. Ouvrard. By heating to a dull red heat a mixture of magnesia, boric anhydride and potassium hydrogen fluoride, the borate $B_2O_3,3MgO$ is obtained in a well crystallised state. The corresponding compounds of barium, strontium and calcium were also isolated.—On the electrolysis of the oxy-acids. Preparation of β-amyloxypropionic acid and of the diamyline of butanediol, by M. l'abbe J. Hamonet. To prevent the occurrence of secondary reactions with the hydroxyl group, the hydrogen of this group was replaced by an alkyl group, and the potassium salt of this compound electrolysed. No satisfactory results were obtained with α-oxy-acids, but with β-oxy-acids the synthesis was smoothly effected in the required direction.—On the saccharifying action of wheat germs, and on their use in brewing, by M. Lindet. Owing to the extensive use of roller milling, the germ of the wheat is entirely separated from the farinaceous portion of the grain. A comparative study of the action of wheat germs and malt upon a solution of dextrinised starch showed that practically the same amount of sugar was produced in each case. In the case where the wheat germs are employed, the distillery residues will have a higher feeding value.—The legend of *Lepas anatifera*, and of *Vallisneria spiralis*, by M. Frédéric Houssay.—The *Ramy* of Madagascar, by M. H. Jacob de Cordemoy. The author identifies the *Ramy* of Madagascar with *Canarium multiflorum*. This tree exudes a greenish-yellow resin which is formed in the stem in resinous canals which are specially developed in the liberian tissue.—On a new genus of fossil stem, by M. B. Renault. The fragment of stem described was found in a dolmen of Haute-Alsace. It is named *Adelophyton julieri*.—On the presence of a layer of Devonian anthracite at Kouitcheou in China, by M. G. H. Monod. The fossils found in the coal-measures at Lan-mou-tchang, in Koui-tcheou, and in the neighbouring strata show that these are clearly Devonian. This field shows that the vertical extension of the coal in China is greater than had been supposed, and this extension ought to be still further increased.—The culture and reproduction of the salmon (*Salmo salar*) in fresh water, by M. Jousset de Bellesme. The experiments described prove that the culture and reproduction of the salmon is possible in fresh water exclusively. This gives rise to the belief that although the habit of going to the sea is favourable to its development, it is neither very ancient nor absolutely necessary to its reproduction.—On the constitution of the soil at great oceanic depths, by M. J. Thoulet. As a result of the study of sixty specimens taken at various depths by the Prince of Monaco, the views previously put forward by the author are confirmed.—On a small laboratory furnace, by M. Albery Bruno.

ST. LOUIS.

Academy of Science, December 17, 1900.—Dr. O. Widmann read an account of the great St. Louis crow-roost, in which were embodied many facts concerning the life-history and habits of the common crow.—Prof. F. E. Nipher gave an account of some of his recent results in positive photography. He has now found that hydrochinone baths of normal strength may be used. The formula given in each box of Cramer plates yields good results if the mixed bath is diluted with water to one-third strength. The potassium bromide may be left out, and one drop of concentrated hypo-solution must be added for each ounce of diluted bath. The hypo has a most wonderful effect. With the same bath, plates may be developed as positives in the dark room or in direct sunlight. He had even started the developing of a plate in a dark room, where it progressed very slowly, but very satisfactorily; continued the operation in diffused daylight in an adjoining room, and finished the operation in direct sunlight. The process was accelerated by the light, but did not appear to be otherwise changed by the change in illumination. The resulting picture could not be distinguished from those produced by ordinary methods. This picture was shown by means of the lantern. A box of Cramer's "Crown," "Banner" or "Isochromatic" plates may have the plates individually wrapped in black paper, in the dark room or at night, and all the remaining work may be done in the light. A plate is taken from its wrapping into the lighted room and placed in the slide holder. After exposure, it is taken out into the light and placed in the developing bath, and the picture is then developed in the light, and may be fixed in the light. Of course, during the changes the plate should be shielded from the light as much as possible, and the fixing bath may always be covered. But all of the operations may be carried on without any dark-room conveniences that may not be secured even in the open fields. When weak hydrochinone baths are used, the picture, when developed in strong lamp-light, or in sunlight, has at first a golden yellow colour. When left in the lighted bath for an hour

and a half, it slowly darkens to a nearly normal shade, as the details come out more sharply. If the exposure has been correctly made, there will be no trace of fog. With stronger baths the picture comes out in the normal time, and has the normal shade. If the pictures are too dense, the remedy is to reduce the strength of the sodium carbonate solution, or to increase the amount of hypo in the bath. Very fine results are obtained with the sodium carbonate solution at half the strength given in Cramer's formula. When the plate has been sufficiently exposed, a negative of the object can usually be seen upon the plate before development. With long exposure this image is very distinct. It fades out in the bath, and the plate becomes clear. The shadows appear strongly, but indistinctly at first, and of a pink colour, and the high-lights still appear white. The solution remains clear. Too much hypo will cause turbidity and a loss of detail. When the plate is exposed in a printing frame under either a negative or a positive, an exposure of half a minute to diffuse daylight is ample with an ordinary negative. The plate may be over-exposed by placing it for a long time in direct sunlight, and it will then appear on development somewhat like an over-exposed negative. This has not yet been tried with hypo in the bath. Prof. Nipher showed a preliminary diagram, in which exposure and illumination of the developing bath were taken as co-ordinates. The zero condition was represented by a line, and the conditions for producing direct and inverted pictures were represented by areas. He also exposed and developed, in a common bath, in the lighted audience room, negatives printed from negatives, and positives printed from positives. The possible value of radio-active substances acting upon the developing plate in place of, or in addition to, light, was referred to as a most promising field for study.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 14.

ROYAL SOCIETY, at 4.30.—Some Additional Notes on the Orientation of Greek Temples, being the Result of a Journey to Greece and Sicily in April and May, 1900: F. C. Penrose, F.R.S.—The Transmission of the *Trypanosoma Evansi* by Horse Flies, and other Experiments pointing to the Probable Identity of Surra of India and Nagana or Tsetse Fly Disease of Africa: Dr. Leonard Rogers.—On the Influence of Ozone on the Vitality of some Pathogenic and other Bacteria: Dr. A. Ransome, F.R.S., and A. G. R. Foulerton.—On the Functions of the Bile as a Solvent: B. Moore and W. H. Parker.——To be read *in title only*: On the Application of the Kinetic Theory of Gases to the Electric, Magnetic and Optical Properties of Diatomic Gases: G. W. Walker.—Heredity, Differentiation, and other Conceptions of Biology: a Consideration of Prof. Karl Pearson's paper "On the Principle of Homotyposis": W. Bateson, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—The Distribution of Velocity and the Equations of the Stream Lines, due to the Motion of an Ellipsoid in Fluid Frictionless and Viscous: T. Stuart.—On Factorisable Twin Binomials: Lieut.-Colonel Cunningham, R.E.—Concerning the Abelian and Related Linear Groups: Prof. L. E. Dickson.—A Geometrical Theory of Differential Equations of the First and Second Orders: R. W. Hudson.—Brocardal Properties of some Associated Triangles: R. Tucker.—A Note on Stability, with a Hydrodynamical Application: T. J. I'a. Bromwich.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Greek Retreat from India: Colonel Sir Thomas H. Holdich, K.C.I.E.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Capacity in Alternate Current Working: W. M. Mordey. (Adjourned Discussion.)

FRIDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 9.—Electric Waves: Right Rev. Monsignor Gerald Molloy.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Light Lathes and Screw Machines: J. Ashford.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Epidemiological Aspects of Isolation Hospitals: Dr. Arthur Newsholme.

MONDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 3.—Origin of Vertebrate Animals: Dr. Arthur Willey.

SOCIETY OF ARTS, at 8.—The Bearings of Geometry on the Chemistry of Fermentation: W. J. Pope.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Discussion on the Occurrence and Detection of Arsenic in Manufactured Products.

VICTORIA INSTITUTE, at 4.30.—The Wahabies: S. M. Zwemer.

TUESDAY, FEBRUARY 19.

ROYAL INSTITUTION, at 3.—Practical Mechanics: Prof. J. A. Ewing, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Nilgiri Mountain-Railway: W. J. Weightman.

ROYAL STATISTICAL SOCIETY (St. Martin's Town Hall, W.C.), at 5.30.—The Growth of Municipal and National Expenditure: The Right Hon. Lord Avebury, F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Imitative *versus* Creative—a Comparison: W. Edwin Tindall.

WEDNESDAY, FEBRUARY 20.

SOCIETY OF ARTS, at 8.—Some Features of Railway Travelling, Past and Present: Frederick McDermott.

GEOLOGICAL SOCIETY, at 8.—Submerged Valleys opposite the Mouth of the River Congo and of Western Europe: Prof. E. Hull, F.R.S.—The Geological Succession of the Beds below the Millstone Grit Series of Pendle Hill and their Equivalents in other Districts in England: Dr. Wheelton Hind and J. Allen Howe.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1900: E. Mawley.—A Review of Past Severe Winters in England, with Deductions therefrom: Albert E. Watson.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Bacteria and Blood Parasites: C. Beck.

THURSDAY, FEBRUARY 21.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On the Affinities of *Æluropus melanoleucus*, Alph. Milne-Edw.: Prof. E. Ray Lankester, F.R.S., and R. Lydekker, F.R.S.—Étude d'une espèce nouvelle de Lépapèdes: M. A. Gruvel.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—If the discussion on Mr. Mordey's paper is closed, the following paper will be read:—The Electrical Power Bill of 1900: Before and After: W. L. Madgen.

CHEMICAL SOCIETY, at 8.—(1) Isomeric Hydrindamine Mandelates and Phenylchloracethydrindamides; (2) Isomeric Benzylhydrindamine bromocamphorsulphonates and some Salts of *d-l*-Hydrindamine: F. Stanley Kipping and H. Hall.—Condensation of Phenols with Esters of the Acetylene Series. IV. Benzo-γ-pyrone and its Homologues: S. Ruhemann and H. W. Bausor.—Constitution of Bromocamphoric Anhydride and Camphanic Acid: A. Lapworth and W. H. Lenton.—The Action of Acetylchlor- and Acetylbrom-aminobenzenes on Amines and Phenyl hydrazine: F. D. Chattaway and K. J. P. Orton.

FRIDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 9.—Metals as Fuel: Sir W. Roberts-Austen, F.R.S.

PHYSICAL SOCIETY, at 5.—How Air subjected to X-Rays loses its Discharging Property, and how it Discharges Electricity: Prof. Emilio Villari.—(1) On the Propagation of Cusped Waves and their Relation to the Primary and Secondary Focal Lines; (2) On Cyanine Prisms, and a New Method of Exhibiting Anomalous Dispersion: Prof. R. W. Wood.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Automatic Coupling: J. L. Cridlan.

SATURDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (Essex Museum of Natural History Stratford), at 6.30.—Recent Work in Molluscan Morphology: Prof. G. B. Howes, F.R.S.

CONTENTS.

THURSDAY, FEBRUARY 21, 1901.

THE GENESIS OF ART.

The Origins of Art; a Psychological and Sociological Inquiry. By Yrjö Hirn. (London: Macmillan and Co., Ltd., 1900.) Price 10*s*. net.

THE various studies usually grouped under the general term of Anthropology are slowly but surely extending their scope. Not very long ago art was considered to be beyond the realm of science, and its exposition was mainly in the hands of art-critics; but of late years scientific methods have been employed to discover why works of art are created and why they are enjoyed, and to trace the modifications which they have undergone. Those who have paid attention to the subject have recognised, with Bastian, that art is a branch of psychology, and Herbert Spencer and Grosse have also laid stress on the immense importance of art in the evolution of human societies. It is therefore with great pleasure that we welcome an investigation into the origins of art from a psychological and sociological point of view by the learned Finnish savant, Dr. Yrjö Hirn.

Even a casual glance at this clearly and brightly written book will demonstrate that the author has assimilated a mass of information gained from a wide range of reading. A more careful perusal shows that he handles his facts judiciously, and keeps himself well in hand. The deductions are lucidly stated, and the authority for each statement of fact is quoted; the reader has, therefore, every facility for traversing an argument should it not appear at first sight to be valid.

To those who have a fair knowledge of the culture of primitive peoples the book will prove very suggestive, as new light will be thrown upon many well-known facts, and isolated observations will be brought into line.

In the following summary of the main arguments of the book the author's own words have been largely employed, which also will assist towards giving a more complete conception of the work. It is perfectly safe to prophesy that this book will prove of very great value not only to the student at home, but to the investigator in the field.

Despite the generally received dictum of "art for art's sake" it will often be found, especially among primitive folk, that some form of interest, personal, political, ethical or religious, enters into what is regarded as disinterested æsthetic activity. In almost every case where the ornaments of a tribe have been closely examined, it has appeared that what seems to us a mere embellishment is for the natives full of practical, non-æsthetic significance, such as religious symbols, owners' marks, or ideograms, and it is surprising what religious or magical significance lies concealed behind the most apparently trivial of amusements. The dances, poems, and even the formative arts of the lower races possess unquestionable æsthetic value; but this art has generally a utility, and is often even a necessity of life.

The play-theory of Groos, although it unquestionably is explanatory of a great deal, does not account for the origin of the artistic impulse. The aim of play is attained when the surplus vigour is discharged, or the instinct has had its momentary exercise; but the function of art is not confined to the art of production; something is made and something survives. Excitement and intense delight manifest themselves in movement, dances and songs which rather relieve incipient pain than express pleasure, violent movement acting rather as a regulator by which the organism restores itself to its natural state. By the control of the bodily movements, which form its simplest expression, joy may be diverted into the region of thought.

While supplying man with a means of intensifying all his varied feelings, art at the same time bestows upon him that inward calm in which all strong emotions find their relief. It is very difficult for an individual to resist the contagion of collective feeling, and all strong feelings act as socialising factors. A work of art is the most effective means by which the individual is enabled to convey to wider and wider circles of sympathisers an emotional state similar to that by which he is himself dominated.

Grosse and Wallaschek have emphasised the important part rhythm has played in the struggle for existence by facilitating co-operation, and the contagious power of an idea is vastly increased when it is cast in rhythmical form, whether it be the gymnastic dance, unmelodious music, poetry, or decorative art. Later, owing to more complex emotions, simple gymnastic dancing becomes pantomimic, and the drama is evolved. A histrionic element also manifests itself in other forms of artistic production—for example, literature and the formative and decorative arts of design. With the increased importance of the intellectual elements accompanying the emotional states, direct emotional suggestion appears an inadequate means of communication; and in ornament and music, as well as in painting and novels, there will be found an imitation of nature which serves what, in the widest use of the term, may be called an epic purpose.

In the endeavour to secure the transmission and perpetuation of a feeling, the expressional activity gradually loses its purely impulsive character and becomes transformed into deliberate artistic production which is conscious alike of its aim and of the means for attaining it. The more the work grows in definiteness in the thought and under the hand of the artist, the more it will repress and subdue the chaotic tumult of emotional excitement.

The art impulse, in its broadest sense, must be taken as an outcome of the natural tendency of every state of feeling to manifest itself externally, the effect of such a manifestation being to heighten the pleasure and relieve the pain.

Various other influences have all along been at work which have determined the concrete forms of art. Groos has rightly laid stress on the play-impulse, which has been of incalculable importance in the history of art; but there are also, for example, the impulse to attract by pleasing and the imitative impulse. Dramas may have been composed, pictures painted, or poems made in play, or out of a desire to please, or out of an inborn taste for mimicry.

Among primitive peoples, the dance, the pantomime, and even ornament, have been of great importance as means for the dissemination of information. Although

there is but one step between the impromptu dance or poem which tells of a recent occurrence and the work of art which transmits the memory of that occurrence to posterity, yet it appears that there are savages who have no historical art. On the other hand, the historical art has everywhere reached its highest state of development amongst nations who have had to hold their own against neighbouring tribes.

Before discussing the problems of art and sexual selection, of the origin of self-decoration and of erotic art, the author devotes a chapter to a consideration of animal display, and his treatment of the subject is worthy of the attention of zoologists. He arrives at the conclusion that human sexual selection did not create any quality of beauty and that human decoration, like that of animals, is mainly an advertisement of likeness of kind; but, strange as it may appear, scarcely any form of dress or ornament can be quoted which could be considered with certainty an outcome of the impulse to attract or charm the opposite sex. Decorations of various kinds are conferred on young people on attaining puberty, and indicate a new social status, and various subsequent advances in rank have their appropriate decoration. The impulse to ostentation with regard to rank, valour or wealth is undeniably independent of sexual selection. Even where there is no competition between rivals, sexual emotions may still find an artistic expression. Like the courting display of many birds, men may have resorted to song and dance as a mode of overcoming the instinctive coyness of the female after sexual selection has operated; but the strong emotional tension of such periods must in any case seek relief by sound or movement.

It is evident that a pantomimic imitation of any activity must, as exercise and stimulation, facilitate the subsequent real execution of the same activity. Individuals and nations who have grown familiar in play with the most important actions in life's work have thus acquired an unquestionable advantage in the struggle for existence. This holds good alike for the everyday occupations of life as for war. Music and song have especially been useful stimuli to work, partly to overcome natural laziness or inertia, partly to effect unison in the actions of several workers; for instance, the regularity of the action of many peoples is explicable as a result of the rhythmical songs by which their work is accompanied. This applies with equal force to war; hence it is not surprising to find highly developed choral dances in those peoples in whose life war is a customary occurrence. The need of stimulation is never so great as when a man has to risk his life in an open battle, and with this end in view the military singers of some tribes are able to work themselves and their audience up to a pitch of frenzy which is almost equal to that produced by the dances. Courage is also induced by the effort to appear formidable and courageous. Instruction in grimacing even formed a part of the military education of the Maoris. Hence, too, the frightful decorations which so many peoples employ when going on the warpath and the well-known face-shields of some of the tribes of New Guinea and Borneo. The decorative art of warlike peoples is usually characterised by a vigour and originality which dominate also their poetry and dramatic dances, and which are the outcome of an intense and forcible life; but descriptive and figurative art, in the sense of realistic, faithful rendering of nature and life, has never attained any high development among the most military tribes.

Sympathetic magic which is based upon a likeness between things calls forth imitations of nature and life which, although essentially non-æsthetic in their intention, may nevertheless be of importance for the historical evolution of art. Nor is this confined to the primitive or decorative arts. There are many magical dances and pantomimes, and there is an universal belief in the efficacy of incantations and in magical songs and poems.

Every man seeks automatically to heighten his feelings of pleasure and to relieve his feelings of pain. The artist is the man who finds that he can gain such enhancement or relief, not only by the direct action of giving expression to his feeling, but also by arousing a kindred feeling in others. Hence originates in him that desire to transmit his moods to an external audience, and there also arises the endeavour to give the artistic product a form which may facilitate the revival of the original state in an ever-widening circle of sympathisers.

"Beyond the fact that art has been obliged to avail itself of media which have originally been called into existence by utilitarian, non-æsthetic needs, there lies another fact. To these external 'origins' we can also trace some of the most important qualities which we appreciate in a work of art. In this way it is open to us to explain how several of the virtues of art, as we know it, may be derived from the primitive needs which it subserved; how, for instance, the lucidity of art may find its explanation in art's use for conveying information; how the sensuous and attractive qualities of all art may be traced to the need for propitiating favour; how the power that resides in art to trace and stimulate the mind may be transmitted from the days when the artist was appointed to nerve his fellows for work or war. And, lastly, it might be argued that a most characteristic quality of art—the imagination—which is in a sense faith in the reality of the unreal, may have been immensely heightened by the use of art for purposes of magic, which fuses the visible and the invisible."

ALFRED C. HADDON.

THE PARTIAL DIFFERENTIAL EQUATIONS OF MODERN MATHEMATICAL PHYSICS.

Die Partiellen Differentialgleichungen der mathematischen Physik. Nach Riemann's Vorlesungen. Fourth edition. Revised and rewritten by Heinrich Weber. Vol. i. Pp. xvii + 506. (Brunswick: Friedrich Vieweg und Sohn, 1900.)

THE lectures, delivered at the University of Göttingen by Prof. Bernard Riemann in the sessions of 1854-55, of 1860-61 and in the summer of 1862, have, thanks to the volume brought out after Riemann's death under the editorship of Karl Hattendorff, long ranked among the mathematical classics. The third and last edition of "Partielle Differentialgleichungen" appeared in 1882, and two years ago Prof. Heinrich Weber was entrusted with the task of bringing out a fourth

edition. There were three possible ways in which this task could have been fulfilled. One way was to republish the edition of 1882, with trifling additions and alterations. The second way was to retain the existing text, but to add copious notes together with references to recent developments bordering on the subject of Riemann's lectures. The third way was to write an entirely new book, based, indeed, on the earlier editions, but completely brought up to date by the embodiment of the new methods and problems that have come into existence in connection with discoveries in mathematics and physics extending over nearly twenty years from the date of the last edition, and nearly forty years from the time when the lectures were given by Riemann.

Prof. Weber has adopted the last of these alternatives, and by so doing has produced a treatise which will be invaluable to the modern mathematical physicist. How far the present treatise is to be regarded as a new work written by Prof. Weber may be inferred from the fact that this, the first volume only, covers 506 pages, as compared with a total of 325 in Hattendorff's edition, and all the last 350 pages are new.

The first part, dealing with analytical methods, corresponds more or less closely with the first three sections of Hattendorff's edition. It deals with definite integrals, infinite series and the differential equations of common occurrence in physics, especially linear equations with constant coefficients. In this portion we are indebted to Prof. Weber for an amplification of the treatment of Fourier's series and Fourier's double integral theorem, for a more precise treatment of continuity and for entirely new sections dealing with surface and volume integrals, functions of complex variables and conformal representation, and Bessel's functions, the last named addition occupying forty pages.

The second part is entirely new. In it Prof. Weber discusses linear infinitesimal deformations and then gives us a chapter on vectors, in which the modern notions of "curl" and "divergence" are fully explained, and expressions for the curl of a vector given in orthogonal coordinates. This is followed by sections on theory of the potential, including Green's theorem and potentials of ellipsoids. The next section deals with spherical harmonics, and this is followed by a short summary of the principles of dynamics, including the Hamiltonian equations and least action.

The only branches of physics treated in Hattendorff's edition were conduction of heat, elasticity (including vibrations) and hydrodynamics. The absence of any reference to electricity and magnetism is accounted for by the fact that these subjects, together with gravitation, were treated by Riemann in a separate course, of which an edition was also prepared for press by Hattendorff in 1876. The third part of the present volume forms a treatise on the mathematical theory of electricity and magnetism, for which Prof. Weber is thus solely responsible. The fundamental principles of electrostatics and magnetism are based on the hypothesis of a continuous medium, the electrical and magnetic properties of which depend on the existence at every point of space of certain vector quantities satisfying stated laws; and the subject is thus introduced much after the manner adopted by Hertz. Among the problems depending for their solution upon the method of conformal representation, we notice an application of the transformation of Schwarz and Christoffel to the distribution of electricity on a prism, an example which practically amounts to an exposition of this transformation.

The subject of contact electricity, too, receives ample mathematical treatment. Perhaps, however, the most interesting sections are those dealing with electrolysis; and this interest is largely due to the important part which Prof. Weber himself has played in advancing our theories of this difficult subject. A comparison of these sections, in which the problem of electrolysis is made to depend on the solution of differential equations which Weber integrates in certain special cases, with the fragmentary information contained in text-books of forty years ago, is sufficient indication of the progress which has been made during the past half century in developing new fields of study in applied mathematics, and in coordinating and perfecting the mathematical treatment of electricity.

Steady flow of electricity, and the fundamental principles of "electrodynamics" (as it used to be and still sometimes is called), occur in their proper places in the present volume. No mention, however, is made of Hertzian oscillations, which are to be dealt with in the forthcoming second volume in connection with the theory of oscillations in general. The remaining subjects to be treated in the latter volume include conduction of heat, hydrodynamics and elasticity.

Mathematicians will, of course, not be satisfied with the present treatment of such matters as convergence of series and of integrals, and on the other hand physicists will require to supplement the volume with other works containing a fuller consideration of the experimental aspect of the various theories. It was no purpose of Prof. Weber's to aim at completeness in either of these respects. The object of the book is rather to furnish a statement of results both in pure mathematics and in physics, and to indicate the methods by which the former results, used in conjunction with the latter, lead to the mathematical solution of physical problems. As an illustration of the spirit of the book, we may notice the article on semi-convergent series, where the use of these series is explained mainly by the consideration of an illustrative example. Again, as Prof. Weber points out, there are many physical problems which can only be solved by approximate methods of little or no mathematical interest, and these again are omitted.

Now a book of this character appeals to a considerable class of present-day physicists. Forty years ago physical laboratories hardly existed, and the pioneers of physics in this country were Cambridge wranglers who approached the subject from its mathematical side exclusively. Now that physical laboratories are scattered all over the country, and that the working man can attend science classes close to his own door, we are running to the opposite extreme, and there is an ever-increasing class of student who requires to master the mathematics required for his physical studies, but who starts his mathematical reading too late in the day to work up step by step from the very beginning. As was pointed out by Riemann

in the introduction reproduced in Hattendorff's first edition, a science of physics (or more literally "a scientific physics") first existed after the discovery of the differential calculus. A sound knowledge of the differential and integral calculus is assumed in this book, but in Germany such a knowledge is acquired by the majority of students at the commencement of their academic curriculum, a stage where, in this country, many students are still attending lectures on fractions, highest common factor and Euclid. Those possessing the necessary preliminary training will find in Weber's new edition of Riemann an excellent introduction to the methods of applying mathematical principles to the problems of modern physics.

G. H. B.

THE CLASSIFICATION OF EARS.

The Human Ear, its Identification and Physiognomy. By Miriam Anne Ellis. Pp. x+225. (London: A. and C. Black, 1900.) Price 3*s.* 6*d.* net.

A SIMPLE, workable, absolutely trustworthy system is still urgently wanted for the detection of criminals, and if the authoress of this book has succeeded she certainly deserves the thanks of all the Governments of Europe. Whatever worth her method may have when it comes to be applied practically, it has some decided drawbacks when the data are examined on which it is founded.

It so happened that about seven years ago the reviewer came to the conclusion that the external ear ought to yield some clue to the relationship of man and ape, and of one race of man to another. As is well known, the characters of the ear are fully inherited, and afford fairly trustworthy clues to family relationship, of which the authoress gives some good illustrations. Founding his method of observation and classification on data derived from a study of the development and comparative anatomy of the external ear, the reviewer proceeded to examine by hundreds the various peoples and races living on the shores of the North Sea, first on the Continental side, then on the British, to see how far the data he accumulated would support the semi-traditional accounts available concerning the early Saxon invasions of Britain. These observations were continued into the Highlands of Scotland, to Ireland and Wales. To test the "criminal-mark" theory of Lombroso and many others, he examined the ears of more than 800 confirmed criminals, and of more than two thousand inmates of asylums for the insane, situated in parts of the country where he had already examined the ears of the sane. Altogether the ears of more than 40,000 people of different races and of different moralities, besides those of about 300 apes and anthropoids, were examined, but the total results of this elaborate investigation were almost entirely of a negative nature.

The authoress appears to take it for granted, and evidently has not inquired into the matter, that the ear of the criminal is peculiar. If the reviewer's methods and observations are correct, the confirmed criminal's ear is the ear of the average inhabitant of Great Britain. Nor did the ears of the insane differ, on an average, from those of the people from which they were drawn, and if the authoress had carried her observations over a number of men of genius or of high ability, instead of drawing elaborate deductions from single observations, she would probably have arrived at a similar conclusion as to them.

The great difficulty in a matter of this kind is to arrive at a method of classification, and it is in this that all the systems propounded break down when applied practically, and the system propounded here is worse than those that have gone before it. In her classification, the first division is a separation of ears into (1) large; (2) medium; (3) small. Unfortunately, she proposes no definite measurements, but if she did it would be found that a great proportion of ears fell on the limits of the medium line, and it would be a matter of the greatest difficulty to say to which of the great divisions it belonged. There is another great obstacle to the application of measurement of the ear to detection of criminals, of which the authoress is unaware. As Schwalbe showed years ago, and as the authoress may verify any quiet half hour during sermon time, the ear, in the later decades of life, undergoes a very considerable growth—enough to shift the ear of a woman aged forty from the medium division to the large division when she is aged sixty.

The authoress has used one of the most variable and untrustworthy features of the human ear for the purpose of subdividing and indexing the forms in which it is found. She detects in its helix (the upper and posterior border of the ear) five divisions, separated by indentations more or less marked. The three great groups of large, medium and small ears are subdivided according to which and how many of these divisions of the helix are present. In many cases no two observers would agree as to the number of helical subdivisions present, which is not remarkable when it is remembered that the helix on the posterior border is a vestigial structure, the result of the infolding of the free margin of the ear. The amount of infolding does not indicate, as the authoress supposes, certain psychological peculiarities, but merely the degree of retrogression in the ear examined. Like all truly vestigial structures, the infolded margin of the helix is subject to such a variety of forms that it defies classification.

One or two interesting, although minor, points might also be mentioned. The statement that the length of the ear depends on the length of the nose, and that the measurement of the one is identical with that of the other, will be found, on trial, to be the exception and not the invariable rule. In most anatomical works the relation of the breadth to the length of the ear is used as a method of classification; quite a useless one, in the reviewer's opinion. The statement made here is that "the width of the pinna should be at its middle part exactly half its length. . . . Any deviation from these exact measurements at once forms a valuable aid in identification." The scientific part of this book was read in the Anthropological Section at the meeting of the British Association at Bristol in 1898, and many of the observations it contains were made on the ears of eminent men of science. The authoress proposes the term of "otomorphology" to cover the science of the external ear, but from the phrenological character given it by this work perhaps the name of "earistry" were better.

A. KEITH.

OUR BOOK SHELF.

Die moderne Entwicklung der elektrischen Principien. Fünf Vorträge von Prof. Dr. Ferd. Rosenberger. Pp. iii + 170. (Leipzig: Johann Ambrosius Barth, 1898.)

THESE lectures formed a course given to school teachers at Frankfort during the Easter vacation, 1897. Published in book form, they furnish an excellent, though brief, historical survey of the development of electrical theory during the past three centuries. Of all those who have aided in this development, probably none played a more important part than Faraday, for it was he who really laid the foundation of the immense structure of modern theory. This is fully recognised by the author of the present volume, who gives due prominence to the work of Faraday and its influence in the development of electrical principles.

The first two lectures are occupied with the various forms of fluid theory of electric action in vogue down to the early part of the nineteenth century. Beginning at the time of William Gilbert, who may be said to be the first to make any attempt at a physical explanation of electric attractions, we are led through a long series of writings extending to the time when Ampère stated the laws of the magnetic action of electric currents, and brought the subject into the state in which it was found by Faraday. The whole of the third lecture is devoted to the life and experimental work of Faraday, and the great change which he brought about in electrical theory by his introduction of the notion of lines of force. How Faraday's method was so successfully followed by Maxwell, Hertz and others is ably described in the fourth lecture. In an amusing section which here follows, and the significance of which is obvious, the author describes the astonishment of the inhabitants of Mars at the wonders of a railway system established there by an enterprising company of earth-folk, and the elaborate dynamical theories with which the wise men of that planet sought to explain the phenomenon. The fifth lecture contains some exposition of the fundamental principles of mechanics and their relations to electricity. The book is throughout written in very readable style, and its value is much enhanced by numerous extracts from original papers. With the exception of certain instances of misspelling, notably in extracts from English writings, it is free from inaccuracies.

The Birds of Africa. By G. E. Shelley. Vol. ii. Part 2. (London: R. H. Porter, 1900.)

IN this portion of his great undertaking, Captain Shelley commences with the genus Promerops and concludes with the pipits, so that he is still far from coming to the end of the Passerines. In the seven exquisite coloured plates with which it is illustrated, Mr. H. Gronvold fully maintains the high standard of their predecessors, and the text is as full and complete as in the earlier parts.

In his preface the author takes occasion to explain the somewhat unusual arrangement of the Passerines he has seen fit to adopt. "I begin," he writes, "with the Passeriformes and follow on with the Piciformes. The two families of these separate orders which appear to me most nearly allied are the swallows and the swifts, so as I end the Passeriformes with the Hirundinidæ it entails beginning the classification with the Oligomyodæ." This, of course, renders matters perfectly clear. But, we venture to think this half-hearted approximation of the swifts to the swallows is begging the question. Either they are nearly allied or they are not. If the former be the case, they should be placed in the same order. If the latter, the superficial resemblance between the two groups is entirely due to adaptation, and they should be kept as far apart as possible.

On this point we may quote from Prof. Newton ("Dictionary of Birds") that "it should be always and most clearly borne in mind that, though so like swallows in many respects, the swifts have scarcely any part of their structure which is not formed on a different plan; and, instead of any near affinity existing between the two groups, it can scarcely be doubted by any unprejudiced investigator that the Cypselidæ not only differ far more from the Hirundinidæ than the latter do from any other family of Passeres, but that they belong to what in the present state of ornithology must be deemed a distinct order."

While, therefore, we maintain that the author has been ill-advised in his departure from the ordinary classification of the Passerines, this in no wise detracts from the value of his work in other respects. R. L.

One Thousand Problems in Physics. By William H. Snyder, A.M., and Irving O. Palmer, A.M. Pp. 142. (Boston: Ginn and Co., 1900.)

THESE problems are simple numerical exercises, mostly of an elementary character, on hydrostatics, "tenacity and elasticity," statics and dynamics (including gravitation and pendulums), light, sound, heat, expansion of gases, magnetism and electricity. Such a collection of questions should be of much use for class-room exercises. The best way of learning the fundamental principles of elementary physics is undoubtedly to practise making numerical calculations with them, and the large number of questions will enable the book to be used with different classes. Many of the questions could almost be used as oral exercises.

A few questions strike us as being somewhat ambiguously stated. Thus: "A boat weighing 2 tons is moving at the rate of 10 miles per hour when the engine breaks. If the coefficient of resistance of the water is $\frac{2}{5}$, how far will the boat go before it stops?" Even if it is not considered necessary to specify the law of variation of the resistance with the velocity, the units in terms of which the coefficient of resistance expressed should be given, for the result will depend on whether this coefficient represents $\frac{2}{5}$ of a ton at a velocity of 1 mile per hour or $\frac{2}{5}$ of a pound at a velocity of 1 foot per second. Again: "Two strings 6 and 10 feet long, meeting at a point and making an angle of 60°, support a 50 lb. weight. What is the tension on each string?" Here the result depends, not on the lengths of the strings which are given, but on their separate inclinations to the vertical which are not given and cannot be found without further data. The teacher will have little trouble in avoiding these questions.

Peach-leaf Curl: its Nature and Treatment. By Newton B. Pierce. (*Bulletin* No. 20, U.S. Department of Agriculture; Division of Vegetable Physiology and Pathology.) Pp. 204; plates 30. (Washington, 1900.)

THE disease known as peach-leaf curl is due to a fungus called *Exoascus deformans* (Berk.), and seems to be more or less common and destructive wherever peach-trees are grown. It is almost confined to the peach and nectarine and their derivatives; and although its country of origin is uncertain, it has long been known in Europe, and latterly elsewhere. In some countries, as in New Zealand, it has almost extirpated the peach-tree of late years, while the losses from the disease in the United States are said frequently to amount to several thousand dollars annually. The volume before us deals with the subject with the usual American thoroughness. The fungus itself, and the diseased condition of peach-leaves induced by it, are fully described and illustrated, as well as the best means of counteracting its ravages, chiefly by spraying the trees. Although the book is written primarily for the benefit of peach-growers in the United States, it is well worthy of the attention of fruit-growers in other countries where peach-trees are infested by the disease.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Size of the Brain in the Insectivore Centetes.

I do not think that there is any recent mammal which has so small a brain in proportion to the size of the skull as has *Centetes ecaudatus.* In an individual of this species, the property of the Hon. Walter Rothschild, which was lately living in the Zoological Society's Gardens, I found the total length of the brain to be 28 mm., of which no less than 8 mm. were taken up by the enormous olfactory bulbs. The dried skull of that individual—measured along the base and not taking into account the projecting occipital region—was 96 mm. The greatest diameter of the brain is 16 mm.; the skull in that region is from 28 to 40 mm. broad. The small size of the brain relatively to the skull has been frequently commented upon and figured in certain of the early genera of Ungulate mammals; and it may be noted that the measurements which characterise *Centetes,* undoubtedly an early type of mammal, are by no means unlike those of such a genus as *Coryphodon*, judging, that is to say, by the published figures of the brain cast and skull of that animal. The resemblance is increased by the small size of the cerebral hemispheres, and by the *complete* exposure of the corpora quadrigemina in *Centetes.* I hope shortly to give a fuller and illustrated account of the brain of this Insectivore. FRANK E. BEDDARD.

Thermochemical Relations.

In a letter in NATURE of February 7 (p. 348), Signor Carlo Del Lungo calls attention to certain thermochemical equalities, and asks for an expression of opinion as to whether these are the result of a casual coincidence or of a definite law. The equalities in question, if they were not accidental, would have an extremely important bearing on thermochemistry generally, but unfortunately, I believe, they are probably mere accidents of coincidence.

The two instances given would seem to indicate that when two elements combine together, the heat evolved is equal to the sum of that which is liberated when these same two elements combine separately with some third. Thus we have (modifying Signor Del Lungo's equations so as to indicate more clearly that the heat of combination refers to that of the elements taken in their ordinary molecular condition):—

$$\begin{array}{ccccc} \tfrac{1}{2}(2Cl_2, O_2) & + & \tfrac{1}{2}(2H_2, O_2) & = & (H_2, Cl_2) \\ -14 \text{ Cal.} & + & 58 \text{ Cal.} & = & 44 \text{ Cal.} \end{array}$$

and

$$\begin{array}{ccccc} (2H_2, C_{\text{sol.}}) & + & (O_2, C_{\text{sol.}}) & = & (2H_2, O_2) \\ 19 \text{ Cal.} & + & 97 \text{ Cal.} & = & 116 \text{ Cal.} \end{array}$$

I have little doubt but that such coincidences might be shown to be accidental by the existence of similar sets of compound, the heats of formation of which show no such relationship. Unfortunately, I have with me no thermochemical works to supply the requisite data. An examination of the above instances, however, will, I think, suffice to prove that the coincidences cannot be the result of any definite law.

When we expand the first of the above equations so as to represent all the stages involved, and the combinations and separations of the atoms in the various molecules, we get:—

$$[-(Cl, Cl) - \tfrac{1}{2}(O, O) + (2Cl, O)] + [-(H, H) - \tfrac{1}{2}(O, O) + (2H, O)] = [-(H, H) - (Cl, Cl) + 2(H, Cl)],$$

which simplifies into

$$(Cl_2, O) + (2H, O) = (O, O) + 2(H, Cl).$$

This would mean that any pair of the four groups of atoms in the following diagram would combine together in any way, and yet liberate the same amount of heat—*i.e.* the thermal result would be the same whether the products were oxygen gas and hydrogen chloride, or water and hypochlorous anhydride.

$$\begin{array}{c|c} O & 2Cl \\ \hline O & 2H \end{array}$$

This, if established as a generality, would be of fundamental importance. But it is inherently improbable, and the existence of the second instance given by Signor Del Lungo seems to render it untenable. If it were true as regards the gases figuring in the above reaction, it would certainly not be true if one of the products concerned were in the solid condition; if, for instance, we dealt with solid instead of gaseous oxygen, there would be a divergence from equality equal to the heat of condensation and solidification of oxygen. Yet the second instance given by Signor del Lungo contains terms of this very character. When treated as above, assuming for the sake of simplicity that solid carbon molecules contain only two atoms, it gives

$$\begin{array}{c|c} C & 2O \\ \hline C & 4H \end{array}$$

Thus the two instances given, inasmuch as they are necessarily dissimilar, must by their coincidence show that this coincidence is the result of accident, and not of any thermochemical law.

Woolacombe, February 12. SPENCER PICKERING.

The Fraunhofer Lines in the Spectrum of the Corona.

In some of the preliminary reports of the observations made during the last eclipse, undue importance appears to have been attached to the supposed absence of the Fraunhofer lines from the spectrum of the corona. Mr. Newall, for instance (*Roy. Soc. Proc.*, vol. lxvii. p. 365), says, "it is difficult to reconcile the marked polarisation (of the coronal light) evidenced in this investigation with the absence of Fraunhofer lines in the spectrum of the corona." Mr. Abbot, whose bolometric observations appear to him to indicate that the corona does not reflect much solar light, states that "additional evidence against the theory of reflecting particles is found in the Indian eclipse spectroscopic results of Campbell, who found a continuous spectrum from the inner corona with total absence of dark lines" (*Astrophys. Journ.*, vol. xii. p. 75).

Prof. R. W. Wood (NATURE, vol. lxiii. p. 230) has already suggested a partial reconciliation of the apparently conflicting observations, but there are other points which do not seem to have received sufficient attention.

It must be remembered that the Fraunhofer lines were observed in the corona of 1871 by Janssen, and were subsequently photographed by Schuster in 1882, and by Hills in 1893, besides having been seen by various observers on other occasions. Great weight seems to have been attached to the photographs taken in 1898 and 1900, in which no dark lines were recorded, but I venture to suggest that the apparent absence of the lines on these occasions was mainly due to the use of spectroscopes of too great a dispersion to exhibit them. While great dispersion is well adapted to render the bright line spectrum more effective, it is clearly fatal to the dark line spectrum, as in the observation of solar prominences. As a matter of fact, the recent photographs only show continuous spectrum extending to a few minutes from the sun's limb, and if one may take the evidence of the prismatic cameras, this arises mainly from the bright line giving inner corona, which probably does not shine chiefly by reflected light, and would, therefore, not necessarily show the Fraunhofer lines. This view accords well with Schuster's account of the photograph of 1882, in which it is stated that near G there was a sharp decrease in intensity at 0·29 of the solar radius from the limb, a further falling off in intensity at 0·60, with the spectrum fading out of view at 1·47; in the lower regions the spectrum was perfectly continuous, but in the upper regions the solar line G was reversed. Captain Hills also found, in 1893, the Fraunhofer lines only at a considerable distance from the limb. Stone, too, in 1874, observed the dark lines in the outer, but not in the inner corona. In these early observations and photographs we may take it that the dispersion of the spectroscopes employed was much less than in 1898 and 1900, and it would therefore seem desirable to search for the Fraunhofer lines in the next eclipse with instruments of smaller dispersion than those recently in use for the bright line spectrum and special observations.

It may be further remarked that as we do not see a section of the sun, the outer corona must be superposed upon the inner, and the fact that the Fraunhofer lines have not been observed or photographed in the inner corona, even with small dispersion, is sufficiently explained by the superposition of the dark line spectrum on the much stronger continuous spectrum of the inner corona. Such superposition would, of course, be more effective

in obliterating dark lines than bright ones. Prof. Wood's suggestion as to reducing the effective intensity of the truly continuous spectrum by passing the light through a suitably placed Nicol's prism, would accordingly be specially applicable to the inner corona.

Prof. Wood has obtained experimental evidence on a point to which attention was drawn many years ago by Ranyard (*Mem.* R.A.S., vol. xli. p. 353), namely, that if the solar light be reflected by small particles in the corona, the reflected rays will be deficient in the rays of greater wave-length. In this way the bolometric observations indicating that the corona was cooler than the bolometer are partly explained. Is it possible that the observations are to be completely explained by further supposing that the bolometer strip was outside the image of the shallow inner corona, which is probably the chief part of the corona directly emitting light and heat? The image thrown on the strip appears to have been little more than one-third of an inch in diameter, and in the account of the observations Mr. Abbot simply states that the image was brought almost tangent to the strip, so that the strip may very well have been 4 or 5 minutes from the sun's limb.

At all events, there seems to be no sufficient ground, as yet, for rejecting the view that the luminosity of the outer corona is largely due to reflected solar light, while that of the inner corona is partly due to the incandescence of solid or liquid particles and partly to gaseous radiations. A. FOWLER.

Royal College of Science, South Kensington, February 9.

Malaria and Mosquitoes.

I THINK most of those who have had much experience of the Indian jungles would be prepared to corroborate the remarks made by Mr. D. E. Hutchins in last week's NATURE (p. 371), and would perhaps be inclined to think there may be something in the opinion alluded to by him, that "Dr. Ross's splendid discovery does not quite cover the whole ground." In 1873-4 I spent some months in the notoriously malarious region at the foot of the Darjiling Himalayas, which contained some tea gardens here and there at that period, while many new ones were being opened out. The planters suffered greatly from malarial fever, and I was told by several that it was far more prevalent, and of a worse type, on gardens in process of formation, by clearing the jungle and breaking up the ground, than on either the undisturbed jungle itself or on gardens that had existed for some time. In other parts of India my camp has suffered badly from malarial fever when mosquitoes were certainly not prevalent, and when, to the best of my belief, there were none, or perhaps I should rather say, none made themselves noticeable by stinging.

On the other hand, when in Upper Assam in 1874-5, I was informed by some of the planters there, and it seemed to be a commonly received opinion, that mosquito curtains were a valuable protection from malaria. Of course at that period no explanation could be given for the supposed fact, which seemed a very mysterious one, as for the invisible 'germs,' which were thought by some to float in the air, to be excluded by curtains of ordinary mesh would be something like a man being prevented from crossing a road through inability to squeeze himself between the milestones.

18 The Common, Ealing, February 12. F. R. MALLET.

Audibility of the Sound of Firing on February 1.

THE following note was recorded here (at Littlemore, Oxford) immediately after I was called away from listening; and as it is more detailed than any I have seen, I daresay you will think it worth printing.

I held my watch in my hand and observed the sequence of the booms for some ten or twelve successive minutes. The second one showed there was regularity, and after the third the facts were clear. The sounds reached us thus:

0s. to 20s., continuous unbroken roll of guns of slightly different strength.

20s. to ± 24s., silence for 4s. or 5s.

± 24s. to ± 29s., similar roll.

± 29s. to ± 34s., silence for 3s. or 4s.

± 34s. to ± 38s., a similar roll.

± 38s. to 42s., silence to just the 42s.

42s. to 45s. exactly, a short roll culminating in three or four guns *much* louder than any of the preceding ones.

45s. to 60s. exactly, dead silence for a quarter minute.

This recurred with such perfect regularity that there was no doubt whatever about the precision of the observation.

Then I had to ride away on a bicycle about a mile, where I met another cyclist, and we stopped and listened again. The long 20s. roll was now missing, but punctual to the second or two came all the others, the last one with big guns precise.

It seems likely that the long roll was the *simultaneous* salute of the long line of ships; but I have not yet noticed any authoritative statement as to how the saluting was done. It was interesting to think that at any moment while we were listening there were no fewer than six other such salutes travelling up towards us from the Solent.

From the strength of the sounds I should quite agree with the opinion expressed in Oxford that they might well be heard another twenty miles. W. J. HERSCHEL.

February 12.

The Origin of the "Tumbling" of Pigeons.

IN reading the account of tumbler pigeons in Darwin's "Animals and Plants under Domestication," the question arose to what the habit of "tumbling" might be due.

I have since seen, in a report of an address by Prof. J. A. Thomson to the North British Branch of the Pharmaceutical Society, a statement that the peculiarities of movement of the Japanese waltzing mouse are due to the fact that only one of its semi-circular canals is developed.

It occurred to me that a similar condition might explain the movements of the tumbler. I should be much obliged if you or any of your readers could tell me where information concerning either of these examples is to be found. E. P.

February 3.

[Prof. Thomson's statement is not quite accurate. The paper to which he referred is undoubtedly that by Rawitz, in *Archiv. f. Anat. and Physiol.* (Physiol. Abth.), 1899, pp. 236-244, where it is shown that of the three canals the anterior is alone normal, and that the other two—though reduced and abnormal in their inter-relationship—are present.

The physiology of the organ has been since experimentally investigated by Alexander and Kreidl, whose paper is in Pfluger's *Archiv. f. Ges. Physiologie* (Bd. 82, pp. 541-552); and as to the pigeons, they, too, have all three canals well developed. Concerning their membranous labyrinth, some experiments of interest were made in, I think, the early nineties by Spamer and others, and an account of these and of allied investigations bearing on the question raised (by McBride) will be found in the *Journ. Anat. and Physiol.* (vol. xvii. pp. 211-217). There does not appear to be any foundation for the view to which the writer of the letter inclines.—G. B. HOWES.]

Lummer's "Photographic Optics."

THE interesting review of Prof. Silvanus Thompson's translation of Dr. Otto Lummer's "Photographic Optics," which was published in NATURE on January 3, has come under my notice. I should be obliged if you would permit me to correct a mistake which occurs both in Prof. Thompson's book and the review. Concerning the two views of Munich published in Prof. Thompson's work, which are there attributed to Dr. Miethe, you remark: "Miethe's two views of Munich from a distance of about two miles—the one taken with an ordinary lens, the other with the teleobjective—show what a powerful weapon the latter is."

Both the views in question were taken by my firm, one with an antiplanet and the other with this antiplanet in combination with a magnifying system (negative lens) as a teleobjective of our own construction and manufacture. I send you a prospectus of my firm concerning the said teleobjective and containing also the two views of Munich.

I also observe another error in Prof. Thompson's work; the lenses recently introduced by Messrs. R. and J. Beck being described on p. 80 as Messrs. Voigtländers' Collinears, instead of our orthostigmats, for which I have given them a manufacturing license, as you will see in the notice on page 1 of the prospectus I also send by book post. RUDOLF STEINHEIL.

München, February 5.

NOTHING could have been further from my intention than to do any injustice to Dr. Steinheil or his firm, and I hasten to acknowledge the justice of his criticisms upon the slips

contained in my edition of Lummer's book—slips for which I take the entire responsibility. The error on p. 100 in supposing that the Munich view was photographed by Prof. Miethe, of Berlin, arose from a confusion between two sets of telephotographic views sent me from Germany, some of which were taken by Prof. Miethe. I would point out that, in the only case in which the kind of lens used is stated, it is correctly stated to be a Steinheil's lens. I presume Dr. Steinheil is not dissatisfied with the performance of the lens in producing the picture, by whomsoever it was photographed. The other point arose from inserting at the last moment, when the sheets were going to press, a reference to Messrs. R. and J. Beck, which should have been inserted at the end of paragraph four instead of paragraph three of Chapter xi. Let me assure Dr. Steinheil that both points will be corrected in any fresh issue of the text.

February 9. SILVANUS P. THOMPSON.

The Ash Constituents of Some Lakeland Leaves.

ALTHOUGH it cannot be maintained that the amount of inorganic matter which the leaves of a tree extract from the soil on which it grows is quite independent of the chemical composition, &c., of that soil, it was deemed advisable to perform a few experiments bearing on this particular feature. Notwithstanding the considerable elevation, viz. about 400 feet, the soil in this locality is distinctly suited and adapted to the growth and healthy development of most of our well-known forest trees. It is a cold, basic clay, mostly not very stiff, on account of the presence of some gravel and peat in many places, and, generally speaking, enriched with considerable quantities of potash, silica and manganese, while a serious deficiency in lime is attested by the universal prevalence of distinctly calcifuge plants. The percentage of crude ash set down in the subjoined table was calculated from the combustion of the leaves gathered in the evening, dried first in the air and then at 100° C. The details are as described :—

Leaves of	Date	Percentage of crude ash	Percentage of lime (CaO) and of silica (SiO_2) in the crude ash
Sycamore ...	May 16	5·6	
,, ...	July 5	6	
,, ...	Aug. 13	10·5	
,, ...	Sept. 13	13	
,, ...	Oct. 11	14·2	$27SiO_2$ & 33·3 CaO.
,, (brown)	Oct. 28	15	
Wych elm ...	June 10	7·8	
,, ...	July 19	11	
,, ...	Sept. 1	13·2	
,, (yellow)	Oct. 17	18	$30SiO_2$ & 32·3 CaO.
Rowan	May 30	5·5	
,, ...	Aug. 2	6	
,, ...	Sept. 15	6·6	
,, and stalks (red)	Oct. 28	6·6	$12SiO_2$ & 35·3 CaO.
Com. beech ...	Sept. 26	5·38	$22·8SiO_2$ & 33·1 CaO.
Copper beech ...	Oct. 2	6·9	
Birch (600 ft.)...	Sept. 6	2·8	
Scots pine ...	Aug. 28	2·5	

The steady increase in the quantity of ash in the leaves of sycamore and wych elm as the season progresses is here exhibited with sufficient emphasis. The peculiarity, however, is that in the case of the sycamore the percentage does not reach the figure that it might do on other soils or under other circumstances; for instance, according to Schleiden and Schmidt, it might come up to 28 per cent.; but this proportion, I make bold to say, is never attained in any part of British Lakeland. The surprisingly large percentage of silica and lime in the ash of the deep crimson leaves and petioles of the rowan demands further investigation, inasmuch as this is a rather calcifuge tree, and the amount of silica in other allied Rosaceans is very small. According to Rismuller, the ash of dry beech leaves is 4·6 per cent. on May 7 and 11·4 per cent. on November 18; whereas Gueymard found that when gathered after natural fall and dried they yield only 5·6 per cent. ash, and my experiments do not warrant the assumption of any serious difference as respects inorganic constituents between the vernal and autumnal foliage of this tree. "Alone among the species of the first order of Mid and North Europe," says MM. Fliche and Grandeau, "the Scots pine seems to seek out siliceous soils, but the physical rather than the chemical conditions of the soil seem, as regards this species, to have a preponderant influence." Nevertheless, the percentage of ash in its first and second years' leaves is precisely the same here as it is in North Germany, and the extremely moderate inorganic pabulum that suffices to sustain it and the birch enables them to bear the privations of an upland abode. P. Q. KEEGAN.

Patterdale, Westmorland.

An Earthquake on February 10.

IN the early hours of February 10, in the town of Grazalema, there was experienced an intense earthquake, with damages to buildings, many of them being rent.

The duration was about three seconds, and the movement a compound one of oscillation and trepidation, accompanied with considerable noise.

The people ran out of the houses full of terror.

The church of Saint Joseph and some other large buildings have been very severely damaged, and also factories and mills.

The body of water that provided motive power for the machinery in one of the factories has disappeared.

Grazalema is a town of 10,000 inhabitants, situated in a hilly district of the province of Cadiz, at about 70 kilometres, nearly due north, from Gibraltar. AUGUSTO ARCIMIS.

Instituto Central Meteorologico, Madrid, February 13.

The late Prof. Hermite.

YOUR interesting memoir of Prof. Hermite differs in one detail from the account in "Men and Women of the Time." It is said there that he was born at Dieuze, in Lorraine, and that he was for a while at Nancy before going to Paris.

W. B. C.

THE RADIO-ACTIVITY OF MATTER.

AT the commencement of the year 1896, in carrying out some experiments with the salts of uranium, the exceptional optical properties of which I had been studying for some time, I observed that these salts emitted an invisible radiation, which traversed metals and bodies opaque to light as well as glass and other transparent substances. This radiation impressed a photographic plate and discharged from a distance electrified bodies—properties giving two methods for studying the new rays.

The phenomenon does not appear to be influenced by any known external cause, such as a variation of temperature or a luminous excitation; it is entirely different from phosphorescence; is not weakened in an appreciable manner by time, even at the end of several years; and is emitted spontaneously without any apparent exciting cause. The radiating property appeared, firstly, to be bound up with the presence of the chemical element uranium; the metal discharges electrified bodies three to four times faster than its salts.

If some fragments of uranium or of one of its salts are placed upon a photographic plate wrapped in black paper or covered by an aluminium leaf, and if between the uranium and the plate various substances are interposed, there is obtained at the end of several hours or days, radiographs showing that the radiation is propagated in straight lines, and traverses different bodies unequally. In the radiographs the edges of the plates of glass, or of thin plates of other substances, throw a sort of shadow, which is still unexplained. This phenomenon, as well as an inequality obtained twice accidentally through parallel and crossed tourmalines, led to the belief at the commencement of these researches that these rays had properties in common with light. But all the later experiments have shown that the new radiation undergoes neither reflection, refraction nor polarisation.

The uranium radiation dissipates with equal rapidity either positive or negative electric charges; the effect is unequally transmitted through screens of different materials according to their nature and according to the order in which they have been simultaneously interposed. This fact leads to the prediction of the heterogeneity of the radiation. The dissipation of the charges of an electrified body submitted to the uranium radiation takes place through the action of the surrounding gas, which is thereby made conducting; the air keeps this property during some instants, and if, after having been influenced, it is blown on to an electrified body, the latter is discharged. A sphere of uranium remains charged if it is placed in a vacuum; in air it puts itself in equilibrium as regards potential with the surrounding space. The rate of leak increases with the potential, and, for high potentials, tends to a constant.

If two conductors are arranged at some centimetres apart, one of which is connected with a source of electricity, and if a piece of uranium is brought near, there is established between the two conductors a continuous current of electricity. Such are the principal facts that I had observed.

In 1897 Lord Kelvin and Messrs. Beattie and S. de Smolan varied the conditions of the preceding experiments, and showed that the uranium radiation established between two metals in air the same equilibrium as a drop of water which united them. In 1899 Mr. E. Rutherford made it clearly apparent that the conductibility set up in gases by uranium was due to a phenomenon of ionisation identical with that which, according to the experiments of Prof. J. J. Thomson, is provoked by the Röntgen rays.

In 1898 the discovery of new radiating bodies gave a new and fruitful impulse to these studies. Mme. S. Curie and M. Schmidt had recognised that thorium possesses analogous properties to those of uranium; then Mme. Curie observed that certain uranium minerals were more active than either metallic uranium or thorium. M. and Mme. Curie concluded from this that there existed other radio-active bodies, and undertook to isolate them.

I cannot analyse here the chemical part of the fine work of M. and Mme. Curie, who, working with the electrometer as the chemist works with the spectroscope, succeeded in extracting from pitch-blende two very active substances: on the one hand, a product containing bismuth and a body which they called polonium; and, on the other hand, a mixture of barium and another new substance, radium.

When they had prepared some centigrams of products the activity of which, progressively increasing, became several thousand times greater than that of uranium, M. and Mme. Curie were good enough to give me some milligrams, so that we could thus pursue parallel researches on the new properties.

M. and Mme. Curie recognised, among other important properties, that these bodies excite the fluorescence of the platinocyanides; that the salts of radium are spontaneously luminous; and further, that all bodies receiving the new radiation become radio-active in their turn, but that they gradually lose this property with time. They observed also, as well as Giesel, who prepared mixtures analogous, but less active, to those of M. and Mme. Curie, that the salts of radium increase spontaneously in activity for some time after their preparation, whilst the activity of polonium salts diminishes. The new radiation produces various chemical actions, alteration of the platinocyanides, violet coloration of glass, production of ozone, &c.

For my part, I have observed that the polonium radiation does not traverse even black paper; it is much less penetrating than that of radium, which, moreover, provokes in bodies which it encounters a secondary penetrating radiation which marks a photographic plate in the immediate neighbourhood of the points struck. I have been able to establish also that the intensity of the phosphorescence excited by radium varies as the inverse square of the distance of the excited body from the radiating source; that the unequal weakening produced by a given screen on the phosphorescence of different substances furnishes a new proof of the heterogeneity of the exciting radiation; and, lastly, that the radiation of radium restores the property of becoming phosphorescent by heat to such bodies as fluor spar, leucophane, &c., which had lost this property by a preliminary heating.

I would here point out the very interesting researches of M. and Mme. Curie, M. Owens, and of Mr. E. Rutherford upon the penetrating rays of thorium. Mr. E. Rutherford has found that thorium compounds emit, in addition to this ordinary radiation, a very penetrating "emanation" that produces temporary radio-activity in substances in the neighbourhood, if the bodies are all uncharged. With charged conductors the radio-activity is produced on the negatively charged body. The radio-activity can thus be concentrated on the surface, of thin wires, and removed by hydrochloric and sulphuric acids, whose solution, when evaporated, leaves the active portion behind. Thorium may perhaps owe a part of its properties to a new element, actinium, discovered in 1900 by M. Debierne, and which is as active as radium.

At the end of 1899 several observers discovered, nearly simultaneously, that the rays from certain radiating substances were deviated by a magnetic field. This was first shown by M. Giesel with preparations of polonium and radium, then by MM. S. Meyer and E. v. Schweidler, who some days later showed the same thing with preparations made by M. Giesel, and then, a little later, without having any knowledge of these observations, I recognised that the radium radiation concentrated itself upon the poles of a non-uniform magnetic field, whilst the radiation of polonium prepared by M. and Mme. Curie is not deviated. The preparation of polonium of M. Giesel was, then, not the same substance as that of M. and Mme. Curie.

It resulted from these observations that there exists two kinds of radiations, one not capable of deviation and of which the nature is still unknown, the other capable of deviation, which later experiments have identified with the kathode rays. Somewhat later, M. and Mme. Curie recognised that both these rays coexisted in the radium radiation. The non-deviable rays are much less penetrating than the deviable rays; the polonium radiation is limited in air to a kind of sheath of some centimetres in thickness. I might add that recently M. Villard has proved the existence in the radium radiation of very penetrating rays which are not capable of deviation. M. Debierne has recognised that actinium emits some deviable rays.

I have devoted numerous experiments to the study of the deviation of radium in the magnetic field. This radiation is dispersed by the field into rays of different natures, like as light is dispersed by a prism. For each simple radiation, the trajectory in a plane perpendicular to a uniform field is a circumference of radius R, which brings back the radiation to the point of departure. If the radiation makes at the origin an angle a with the axis of the field, the trajectory is a helix rolled on a cylinder parallel to the field and of radius R sin a. The product $H\rho$ of the component of the field normal to the displacement at a point, by the radius of curvature of the trajectory in this point is constant, and may serve to characterise each simple radiation.

To obtain a beam in which each simple radiation would have a unique trajectory, a radiant source may be taken of very small diameter, the radiation being received after traversing a narrow gap in a sheet of lead.

It is shown by experiment that it is sufficient to arrange between the polar pieces of an electromagnet a horizontal photographic plate upon which is placed, in the centre of a little leaden dish, the radiating source of very small diameter. The rays emanating normally to the plate and brought back orthogonally on it are the most efficacious; the impression, large and diffuse, is thrown on one side of the field, and constitutes a sort of spectrum which is sufficiently pure. If one works in the dark, and places on the photographic plate bands of various substances, aluminium leaf, copper and platinum foil, &c., it is seen that under the screens the impression of the deviated rays is limited by elliptic arcs, distinguished from each other. Each screen arrests different radiations, the most deviated being the most absorbable. The dimensions of the elliptic arcs are in accordance with theory. The absorption is the same in air and in an absolute vacuum. These experiments constitute a sort of magnetic spectrum analysis of the deviable radiation.

The identification of this radiation with the kathode rays requires two other verifications—the demonstration of the existence of a transport of electric charges and that of a deviation in an electrostatic field. M. and Mme. Curie have made the first verification, and I have realised the second. M. and Mme. Curie placed a screen, isolated from all contact with the air, in connection with an electrometer, and observed that the radium radiation charged this screen negatively, whilst the source itself, if it is properly isolated, is charged positively. The current for each square centimeter of radiating surface was about 4.10^{-13} electromagnetic C.G.S. units.

For my part, I showed that in an electric field the radiation of radium undergoes a parabolic inflection in the contrary sense to the field, as would be the case with a flux of negatively charged particles. The comparison of the electrostatic and magnetic deviations allows of the determination, like that of Prof. J. J. Thomson for the kathode rays, of the velocity of the particles. For the particular radiations defined by $H\rho = 1600$, the velocity has been found equal to 1.6×10^{10}—about one-half of that of light. The ratio of the material masses carried off to the charges which they transport has been found equal to 10^{-7}, a number identical with that corresponding to the kathode rays. From these numbers, and that which results from the experiment of M. and Mme. Curie, it follows that for each square centimetre of surface of the radiating substance studied there escapes a flux of material which would amount to a loss of about one milligramme in one thousand million years. If the material emission, which appears to be of the same order as the evaporation of certain scented substances, is the first cause of the observed phenomena, there would be no contradiction between the apparent absence of any source of energy and the continuous emission of this energy.

The most deviable portions of the radium radiation pass easily through all bodies when they are very near the source, but are stopped when these bodies are some centimetres distant. I have further recognised that, after having traversed a screen, the radiation possesses the same magnetic deviability.

I can only give here the physical properties of radio-activity. One of the most important applications has been the discovery, by M. and Mme. Curie, of new chemical elements. Radium has a high atomic weight, and a characteristic spectrum observed by M. Demarçay. Polonium, according to recent researches, has a spectrum in the ultra-violet. These bodies possess, then, the characters of simple substances.

Recent studies on induced radio-activity appear to open still new horizons. It has been mentioned already that a body becomes temporarily active when it receives the radiation of an active body. M. and Mme. Curie and M. Giesel have recognised that the induced activity thus provoked was much greater if the body was mixed in solution with an active salt and then afterwards separated by precipitation. In thus rendering barium active with actinium, M. Debierne has recognised that the active barium behaves as a different body from ordinary barium, that it could be separated chemically and concentrated. Active barium thus resembles radium. It differs from it by the absence of a peculiar emission spectrum and by the fact that its activity weakens with time. I would add that recently Sir W. Crookes, who has made numerous experiments by the photographic method, announced that he had prepared uranium that was almost inactive. According to these experiments, as well as those of M. Debierne, M. Giesel and myself, it would appear to follow that the activity of uranium is due in great part, if not altogether, to a small quantity of actinium or of another radio-active body.

These facts, although increasing the complexity of radio-activity from the chemical point of view, do not, however, remove from it its value; it can be remarked that if the existence of uranium as a simple body had been unknown up to the present, its radiant properties would have permitted of its isolation, even though they are not inseparable from its existence.

This short account shows that a new order of phenomena has arisen from the study of a new property of matter—radio-activity. HENRI BECQUEREL.

PROGRESS OF THE MAGNETIC SURVEY OF THE UNITED STATES.

THE special division of the United States Coast and Geodetic Survey devoted to the magnetic survey of the United States, and countries under its jurisdiction, was created by the late superintendent, Dr. H. S. Pritchett, now president of the Massachusetts Institute of Technology, on July 1, 1899; and Dr. L. A. Bauer was put in charge of the division. Since that date magnetic observations—namely, declination, dip and intensity of magnetic force, have been made up to December 31, 1900, at about 500 stations distributed over the United States, Alaska and the Hawaiian Islands. At most of the stations permanent marks have been established for the use of the surveyor. Special consideration has also been given to the needs of the mariner, especially in Alaskan waters, where occur places of pronounced local attraction affecting the compasses on board ship all the way from $\frac{1}{4}$ of a point to 4 points.

Special stations, known as "repeat" or "secular variation" stations, have also been established in different parts of the United States. At these, observations will be repeated at stated intervals in order to determine the amount of secular change in the magnetic elements. It is the endeavour, whenever possible, to establish such stations in the vicinities of colleges and universities, as experience has shown that on college grounds there is hope for a permanency of station for a fairly long interval.

Of special State surveys mention may be made first of the completion of the magnetic survey of Maryland, which was undertaken primarily by the Maryland Geological Survey and assistance rendered by this Bureau; second, the completion of the magnetic survey of North Carolina, conducted under the joint auspices of this Bureau and the North Carolina Geological Survey; third, the completion of the magnetic survey of West Virginia; and fourth, the completion of the magnetic survey of Iowa.

Fair progress has also been made in the establishment of the magnetic base stations, where the countless variations of the earth's magnetism will be recorded photographically. Thus, a temporary magnetic observatory

has been in operation at Baldwin, Kansas, since July 1, 1900, and the buildings for the primary or principal magnetic base station, situated at Cheltenham, Md., sixteen miles south-east of Washington, have been completed and the installation of the instruments is now taking place. Special declination readings from 7 a.m. to 4 p.m. have been made at Gaithersburg, Md., since March 22, 1900, and at Sitka, Alaska, since October 1, 1900. The sites for the magnetic base stations at Sitka, Alaska, and near Honolulu, Hawaiian Islands, have been determined and preparations made for the erection of the buildings. It will be the endeavour to have these magnetic observatories completed in time for co-operation with the proposed Antarctic expeditions.

Furthermore, special simultaneous observations have also been made on special days at various times, the purpose of these special observations being to determine over how large an area the variations, as recorded at the base stations, may be regarded as applying.

Again, various special investigations both of an experimental and a theoretical character have been undertaken, and considerable attention has been paid to the thorough training of observers and to the proper correlation of the various magnetic instruments. During the autumn of 1899 a set of coast survey magnetic instruments was compared with the standard instruments at the following foreign observatories: Kew, England; Potsdam, Germany; Pavlovsk, Russia; and Parc St. Maur, France.

The following publications have been issued, namely: Appendix 9, giving a general report of the magnetic survey of North Carolina; and Appendix 10, on the magnetic work of the U.S. Coast and Geodetic Survey, both appendices appearing in the Report of the Survey for 1898–99. Good progress has also been made with the new edition of the Coast Survey's magnetic declination tables and isogonic charts for the United States and Alaska for 1900.

MAX JOSEF VON PETTENKOFER.

It is with great regret that we record the death, in very sad circumstances, of the veteran German hygienist, Prof. Max von Pettenkofer. He was born in 1818, and was, therefore, in his eighty-third year at the time of his death.

Pettenkofer's name was known throughout the civilised world as that of the great professor of hygiene at Munich, and he made the Munich school famous. Among medical and hygienic circles in Europe he was personally well known and respected for his fearless defence of what he believed to be true and for the breadth of his views. Sometimes during a discussion on some subject on which he felt strongly, the burly form of the great German hygienist would arise, and with a few vigorous sentences he would scatter the arguments of his opponents like chaff before the wind. A notable instance of this occurred at the meeting of the International Congress of Hygiene and Demography at Vienna in 1887 during the discussion on quarantine; the supporters of that antiquated method of prevention had most of them aired their views, when Pettenkofer got up and brusquely told them that it was a question of cleanliness, that England had spent many millions in improving the sanitary condition of her towns and had now no fear of cholera, and that what other countries should do was to follow England's example, and then they would have no need for the vexatious and, for the most part, useless restrictions of quarantine.

Pettenkofer published a great many valuable papers on public health subjects; the list of their titles fills nearly a page and a half of the great "Index Catalogue of the Library of the Surgeon-General's Office, United States Army"; and even that is not complete, as it does not include his remarkable paper on "Die Immunität von Lyon gegen Cholera." But he was too busy with teaching the many pupils who flocked to him from all parts of the world, and with investigating, to write large treatises, two on cholera being the longest productions of his pen; this, indeed, was his favourite subject, and his books and papers on it number about a score, the best known of them probably being the one entitled "Boden- und Grundwasser in ihren Beziehungen zu Cholera und Typhus," in which he propounds his well-known theory that the spread of cholera and enteric fever depends upon the movements of the subsoil water, their prevalence increasing after a fall in the level of that water. This view he stoutly maintained, undaunted even by the fact that the City of Lyons (the invariable immunity of which from epidemics of cholera, in spite of several introductions of the disease, he considered quite explicable on his theory) was very subject to enteric fever, from which it ought, on the same theory, to be immune.

Whether, however, we regard his ground-water theory as correct or not, we cannot but admire the practical results of the measures taken under his advice to purify the subsoil of Munich, which, from being a hotbed of enteric fever, has become remarkably free from that disease.

He also wrote on sewerage arrangements, on the hygiene of ships, and on "the relations of the air to clothing, dwelling and soil," the last being a course of popular lectures; and he was co-editor of the *Zeitschrift für Biologie* (München) from 1865 to 1882.

Pettenkofer was much interested in chemical work connected with hygiene, and devised the method (ever since known by his name) of determining the percentage of carbonic acid in air, which has been adopted by all observers until quite recently.

Personally he was gentle and amiable, as a little incident will suffice to show. In 1894 the present writer, not finding him at the International Congress of Hygiene at Budapest, went to see him at his home at Seeshaupt, on the Starnberger See, near Munich; he was crossing on one of the steamers, and, when about half way towards the farther end of the lake, was surprised to meet Pettenkofer on board. The latter had gone some distance round the lake by rail and got on the steamer at one of the stopping places, so as to come part of the way to meet his guest for the day and escort him to his house.

Not having received the usual New Year's greetings from him on a card bearing a photograph of one of the fountains of the "Pettenkofer water supply" at Munich, with a small profile medallion of the professor above it, the writer feared that he was not well, but was little prepared for the terrible news which so soon followed.

It was no doubt his retirement, even at that lovely spot, and his forced inactivity, that preyed upon poor Pettenkofer's mind, and not even the patent of hereditary nobility granted him by the Emperor seems to have solaced him, for we have just received the melancholy and pathetic news that this grand old man, tortured by an incurable disease and wearied by his inability to work any more for the benefit of his fellow-men, has put an end to his sufferings by a pistol shot. W. H. C.

THE ROYAL INDIAN ENGINEERING COLLEGE, COOPERS HILL.

Last week we printed a report, taken from the daily papers, of the deputation to the Secretary of State for India asking for an inquiry into the working of the Royal Indian Engineering College. Lord Kelvin, who headed the deputation, expressed disappointment at the nature of Lord George Hamilton's reply, and if, in criticising that reply, we should fall into error in consequence of the inconsistencies in the reports of the

interview, we must apologise to Lord George Hamilton beforehand if we should unintentionally misrepresent him.

The Secretary of State is of opinion that some of those who signed the memorial have been misled by *ex parte* statements; but the memorial was founded solely on the letters of dismissal and the memorial to the Secretary of State sent by the dismissed members of the staff. Lord George Hamilton seems to forget that Colonel Ottley's report is quite *ex parte*, for the staff have not only not had an opportunity of answering it, but they did not know of its existence until the reply of the Secretary of State was given.

We are assured that none of the letters to the daily papers were written by members of the staff, and the letters from the students were unanimously condemned by them.

Lord George Hamilton stated that Mr. (now Sir Henry) Fowler's committee of 1895, the composition of which it would be interesting to know, was of opinion that the number of the staff was out of all proportion to the number of the students, but we are very much mistaken if comparison with other institutions would not show that the number of the staff is by no means excessive. The numbers of the staff must depend more upon the variety of the subjects taught than upon the numbers of the students. In an engineering college especially, if it be worthy of the name, the variety must be considerable. The percentage of staff to students will decrease with the number of students; at Coopers Hill numbers of students are denied admission each year.

Until Colonel Ottley's report is published in full, it will be impossible to judge of the statement that it shows "a very unsatisfactory state of affairs at the College." That this is so is all the more surprising as the College is now self-supporting. More than this, year after year the Secretaries of State have spoken of the satisfactory state of the College when addressing the students on the prize days, and this after receiving the reports of the presidents.

The state of affairs is certainly unsatisfactory from one point of view. A college can no more get on without college meetings of the teaching staff than a Government can get on without Cabinet meetings of those in charge of different departments. Lord George Hamilton's reply indicates pretty clearly that while the teaching staff is never consulted, it is not quite certain whether the governing body is the Board of Visitors or the president of the College, who has made it quite clear that he knows nothing of educational methods.

It is impossible not to come to the conclusion that the main obstacle to improvement in the work at Coopers Hill has been the unsatisfactory position of the staff; they are entirely under the hands or the heel of the president, who may have had no experience whatever in matters of education. The staff are unable to forward recommendations to the India Office except through the president, and however much they may be desirous of improving the teaching, they are powerless.

There seems to be some misunderstanding about the teaching of electrical engineering. Some years ago several members of the staff urged the then president to introduce electrical engineering as a compulsory subject; the president would not further the proposal. It was next suggested that the subject should be made alternative with some of the other third-year work; this was accepted, and since that time many students have worked at this subject for about fourteen weeks in their third year. Two of the members of the staff who are dismissed were instrumental in obtaining this concession from the president and the India Office. It is difficult to reconcile the desire to have electrical engineering as a compulsory subject with the statement in the *Times* that, "with respect to electricity, the India Office had taken the opinion of Sir William Preece, and came to the conclusion that a demonstrator was capable of giving all the necessary instruction," unless it means that electrical engineering is to be taught as an art and not as a science, which will probably result in the students having an insufficient theoretical knowledge of the science they have to apply, and will certainly lead them into difficulties on an emergency.

The reference to Dr. Brightmore would lead a reader of the speech of Lord George Hamilton, as it appears in the papers, to think that he had been appointed recently to take the head of the engineering branch. Some of our readers will doubtless remember that Dr. Brightmore was appointed in September 1899 against the wishes of the late president, Colonel Pennycuick, and that his appointment was the principal cause of the resignation of that officer.

The statement that "the upshot of the whole matter would be this: there would be an increase in the hours of work in class and lecture from twenty-six to thirty-two" hours per week, is extremely misleading. A reference to the College time-tables would show that before the advent of Colonel Ottley the time of study for first year students was thirty-three hours a week, and for second year students thirty-four. At that time the third year students had in lecture only 14 hours 20 minutes; but no account is taken of the project, the engineering and turbine designs, or the architectural design, which latter was alternative with work in the chemical or physical laboratory, and the hours for which do not appear in the time-table. If the numbers of hours actually spent in lecture by students of the three years are added together and divided by three, a number not far from twenty-six is obtained, but it is very disingenuous to insinuate that in the time of previous presidents the students did only twenty-six hours' work a week.

Another effect of the new scheme is said to be the raising of the standard of the entrance examinations. When the College was first opened the entrance examination was conducted by the Civil Service Commissioners; later, when it was opened to all students who desired to present themselves in order to compete for the Indian appointments in the College itself, the examinations were carried on at the College by some members of the staff, and the number of the candidates was often less than the vacancies. As the order has always been given to the presidents to make the College "pay," there was a tendency to admit as many as possible, so as to fill the building. Of late years the number of candidates has exceeded the vacancies, and the examination has been selective, to the great satisfaction of the staff, who thus have better material with which to work. This stiffening of the examinations has been going on for some time, and is quite independent of the recent dismissals or of Colonel Ottley's report.

Another very misleading statement is that 39 per cent. of the students fail; this is made so as to infer that the teaching is inefficient. This number has probably been arrived at by counting the number of students who enter in one year, and the number of the same batch who obtain diplomas at the end of the third year; but no account appears to have been taken of the fact that many students withdraw of their own accord before completing their college course.

The statement that outside examiners would be appointed might induce a casual reader to suppose that the examinations are carried out by the teachers themselves, as, indeed, the *Times* categorically states, "the teachers were also examiners with no one from the outside." This is erroneous; outside examiners have always been the rule; a large proportion of the marks are given by outsiders, and in some subjects as much as half of the marks are so awarded. The outside examiners are absolutely independent; their papers are not seen by the lecturers.

Extracts of the reports of these examiners are read by the president on the prize day.

What we have stated above quite supports Lord Kelvin's expression of disappointment at the reply vouchsafed to the deputation.

It appears also, from Lord George Hamilton's reply, that he does not consider the men of science employed at Coopers Hill to be servants of the Crown, and that consequently a different measure is to be meted out to them than that proper to the unscientific clerks in a department of the India Office. He is reported to have said that the age limit of the professors at the College is sixty; surely, under the Superannuation Act of 1859, it is sixty-five, and the professor may continue in office until seventy if the president certifies that the work is being efficiently performed.

Under the same Act, if it were desired to reorganise the College, there was a regulated way open which, beyond all question, would be the one employed in any reorganisation of the India Office itself; and surely under these circumstances it was the duty of the representatives of science to ask for simple justice. Chap. VII. of the Superannuation Act runs as follows:—

"It shall be lawful for the Commissioners of the Treasury to grant to any person retiring or removed from the public service in consequence of the abolition of his office, or for the purpose of facilitating improvements in the organisation of the department to which he belongs, by which greater efficiency and economy can be effected, such special annual allowance by way of compensation as on a full consideration of the circumstances of the case may seem to the said Commissioners to be a reasonable and just compensation for the loss of office; and if the compensation shall exceed the amount to which such person would have been entitled under the scale of superannuation provided by this Act *if ten years were added to the number of years which he may have actually served*, such allowance shall be granted by special minute, stating the special grounds for granting such allowance, which minute shall be laid before Parliament, and no such allowance shall exceed two-thirds of the salary and emoluments of the office."

Another point that the noble lord appears to have omitted to answer is Prof. Johnstone-Stoney's contention that the dismissals were not even in accordance with the terms of appointment.

If the above assertions are true, and we have every reason to believe that they are, is it surprising that the dismissed members of the staff should ask for further nquiry? And it is only natural that others, as represented by the signatories of the memorial presented on Tuesday week, should wish to support their application. It would appear that the inquiry is even more urgently needed since we have heard Lord George Hamilton's reply.

But the condition of the staff at Coopers Hill is only a small part of a large question, and the memorialists are quite justified in saying that "such dismissals are likely to affect adversely the cause of scientific teaching in the United Kingdom." An action of this kind by a Government department will not tend to raise the dignity of scientific teaching in the eyes of the general public, and unless England is to fall far behind other countries it is essential that due regard be paid to those fundamental subjects of science on which the welfare of the whole community depends.

All interested in English education, and we may add that their number now includes the more intelligent of our manufacturers, know full well that the rapid strides now being made by American and German engineers are due to a gradual perfecting of the welding of science to practice. In America, a four years' course, including both the science and art of engineering, is the rule in the engineering colleges. The engineering department of the University of Birmingham starts with a four years' course in which those subjects which have been summarily and, as we hold, unwisely, ejected from the Coopers Hill curriculum will hold a large place.

Lord George Hamilton now knows what the representatives of English science think of the proposals for which he is responsible. The opinion of the professional electrical engineers of this country will be gathered from the following comments upon the case, which appeared in last week's *Electrician*:—"The crucial question, therefore, is whether the proposed changes will enable the College to turn out better engineers. What, then, are these changes? They involve the abolition of the chairs of physics, chemistry, hydraulic engineering and mechanism, the assistant professorship of engineering, the lectureship in accounts, the demonstratorships in the mechanical laboratory and in physics, and the instructorship in electrical engineering. The selection is amazing! What sort of engineering college training can it be that can dispense with a teacher for any one of these subjects? And, considering that the supply of telegraph engineers has been one of the chief features of the College, how are we to regard patiently the abolition of the professorship of physics and the instructorship in electrical engineering? This is economy false to the core—so palpably absurd, indeed, that we doubt if economy is the real reason for these startling changes. Lord George Hamilton stated that in the revised curriculum 'electricity would be thoroughly taught,' as Sir William Preece had advised them that 'a demonstrator was capable of giving all the necessary instruction.' We entirely dissent from this view; with the rapid increase in the engineering applications of electricity, not less but *far more* instruction in electrical and allied subjects becomes increasingly necessary in any engineering college."

Of one thing we may rest assured. When the Indian engineers only know chemistry "to the extent required to enable the engineer to interpret results given by professional chemists," as quoted from the official documents by Lord Kelvin; and physics and electrical science as imparted by Sir William Preece's "demonstrator"; the reputation of a noble service, which has during the last quarter of a century achieved such admirable results, will soon be a thing of the past.

NOTES.

WE have received the following circular relative to the dismissals at Coopers Hill College. "In consequence of the unsatisfactory nature of Lord George Hamilton's reply to the deputation which waited upon him on Tuesday, February 12, to present the memorial relating to the dismissals at Coopers Hill, it has become necessary to take action in Parliament. It would be of great service if the signatories to the memorial would draw the attention of their local Member of Parliament to the action of the Secretary of State for India, and ask him to interest himself in the matter when it comes before the House. A copy of the memorial will be forwarded to any signatory on application to The Secretary, The Museums, Cambridge."

AN abstract of an interim report on yellow fever, by Dr. Durham and the late Dr. Myers, has been received by the Liverpool School of Tropical Medicine. The abstract mentions that a small bacillus has been found in the internal organs of those dead of yellow fever. From the fact that this bacillus has been found constantly and in apparently "pure cultures," it is concluded that there is good reason to suppose it to be the cause of the disease, but at the same time the need of more experimental work to establish the claim is recognised. Careful search was made for parasites of the nature of protozoa, but the observers conclude that yellow fever is not caused by that class of parasite.

IN connection with the subject of the foregoing note, it is of melancholy interest to refer to articles in the *Jornal do Commercio* of Para, on the subject of the death of Dr. W. Myers and of the illness of his colleague, Dr. H. Durham, who both contracted yellow fever in the pursuit of their dangerous duties whilst acting on the Yellow Fever Expedition of the Liverpool School of Tropical Medicine. The following is a translation of parts of the articles:—"January 18. Drs. Durham and Myers.—Lying at present in the hospital Domingos Freire are the illustrious English doctors who came here in commission on behalf of the Liverpool School of Tropical Medicine to study yellow fever. Daily exposed to infection from the terrible disease, the day before yesterday, after an autopsy at an early hour on a case of very acute form of yellow fever, they began to feel the first symptoms, and without loss of time entered the hospital. A clinical service was arranged, assisted by numerous colleagues of the illustrious men of science, under the direction of their medical assistant. We sincerely hope for the recovery of the distinguished doctors, who through their noble dedication to science have been rendering us such great services, their investigations having already achieved entirely new results from which we may be permitted to look for promising advantages for our country and for humanity at large." "January 22.—In the isolation hospital Domingos Freire succumbed most rapidly and unexpectedly the English bacteriologist Dr. W. Myers, who came to this capital solely for the study of the disease to which he has fallen a victim—yellow fever. Following on a prolonged autopsy, both Dr. Myers and his illustrious companion, Dr. Durham, fell ill themselves, the latter still being under the burden of the disease. Dr. Myers' death took place on the afternoon of the 20th, and the burial was carried out yesterday morning, the coffin being carried from the hospital to the cemetery of Tanta Isabel by Dr. Paes de Carvalho, Governor of the State of Para, and Drs. Francisco Miranda, Americo Campos, Pontes de Carvalho, Gonçalo Lagos and other gentlemen alternately. At the side of the grave the following doctors spoke:—Paes de Carvalho, who showed by the sadness of his expressions the deep grief which he felt, and Americo Campos, as representative of the Medico-Pharmaceutical Society of Para. There were present a large number of members of the English colony, all in deep mourning and visibly affected."

THE neglect of ethnography in Great Britain has often been pointed out in these columns. In his presidential address to the Anthropological Institute on February 4, Mr. C. H. Read showed that not only is our country far behind other nations in respect to provision for teaching the subject, but also in ethnographical collections and accommodation for them. Germany, with colonial possessions infinitesimal in extent compared with those of England, has completely distanced us in this respect; the British Museum collections from British possessions being inferior to those of the Berlin Museum, which has exhibits seven times as numerous as those in the British Museum, and this disproportion is rapidly increasing. After the Benin expedition we allowed ourselves to be outbid in the purchase of specimens, and Mr. Read said that attention has in Germany been officially called to the fact that England seems to be too poor to be able to compete effectively for objects that are indispensable for her ethnographical collections. Most people will agree with Mr. Read that this state of things is a national disgrace, and shows a neglect of scientific interests as astounding to thoughtful minds as it is deplorable. In the matter of ethnographical material, we are apparently becoming renowned as the nation of lost opportunities. Can nothing be done to stimulate national interest in the collection of objects and conservation of knowledge fast disappearing before the advance of civilisation?

MR. VAUGHAN CORNISH, whose name is closely associated with the wave-like forms assumed by drifted materials, is now engaged on the Canadian prairies photographing and studying the forms assumed by drifting snow. Thanks to the liberality of the Canadian Pacific Railway Company and the interest evinced in the investigation by Sir William van Horne, Mr. Cornish writes that his work proceeds satisfactorily, and enough has already been done to justify the expedition.

THE last mail from Japan brings news that Mr. A. Imamura has been nominated assistant professor of seismology at the Imperial University of Tokyo, where he will work with Dr. F. Ōmori at the Seismological Institute. In addition to this Institute, there is in Tokyo a Seismological Investigation Committee, which has already published thirty-two volumes relating to its work, and also, at the Central Meteorological Observatory, a department which receives and analyses the registers relating to earthquakes observed at about one thousand co-operating stations distributed throughout the Empire.

THE next congress of the South-eastern Union of Scientific Societies will be held at Haslemere on June 6–8, under the presidency of Mr. G. A. Boulenger, F.R.S.

THE inaugural meeting of the Birmingham local section of the Institution of Electrical Engineers, which was to have been held on January 23, has now been fixed for Wednesday, February 27, in the University Buildings. Dr. Oliver Lodge, chairman of the section, will deliver an inaugural address, and the president of the Institution, Prof. J. Perry, F.R.S., will be present.

IT is announced in the *British Medical Journal* that an Italian Society of Biology has recently been founded on the initiative of many distinguished naturalists. The first meeting of the society will probably be held in Rome during the coming Eastertide. The object of the society is to promote the study of the biological sciences and everything relating to the advancement and teaching of these. The society will publish a bulletin giving an account of its proceedings.

ON Saturday next, February 23, Lord Rayleigh will deliver the first of a course of six lectures at the Royal Institution on sound and vibrations. On Tuesday, February 26, Dr. Allan Macfadyen will begin a course of five lectures on the cell as the unit of life, and on Thursday, February 28, Prof. Percy Gardner will deliver the first of a course of three lectures on Greek and Roman portrait sculpture. The Friday evening discourse on February 22 will be delivered by Sir William Roberts-Austen, K.C.B. His subject will be "Metals as Fuel."

THE Paris correspondent of the *Chemist and Druggist* states that M. Berthelot, one of the permanent secretaries of the Paris Academy of Sciences, is taking steps to carry out a resolution of that body to distribute annually a gold medal in memory of Lavoisier. M. Paulin Tasset, the engraver, is preparing the die of the medal, and has taken as a model a medallion of the great chemist in profile by David d'Angers. The inscription will be of the simplest nature. The name "Laurent Lavoisier" will appear under the profile, and on the back of the medal the words "Institut de France, Académie des Sciences, Medaille Lavoisier." The medal is likely to become greatly prized by chemists, and will be given for distinguished chemical research. It will be awarded for the first time this year by the Academy of Sciences, and its annual distribution is assured by a balance remaining over from the subscription for the monument, which was unveiled last summer behind the Madeleine Church, Paris.

THE anniversary meeting of the Geological Society was held on Friday, February 15. The officers were appointed as follows:—President: Mr. J. J. H. Teall, F.R.S. Vice-presi-

dents: Mr. J. E. Marr, F.R.S., Mr. H. W. Monckton, Prof. H. G. Seeley, F.R.S. and Mr. W. Whitaker, F.R.S. Secretaries: Mr. R. S. Herries and Prof. W. W. Watts. Foreign Secretary: Sir John Evans, K.C.B., and Treasurer: Dr. W. T. Blanford, F.R.S. The following awards of medals and funds were made:—The Wollaston Medal to Dr. Charles Barrois, of Lille, the Murchison Medal to Mr. A. J. Jukes-Browne, of Torquay, the Lyell Medal to Dr. R. H. Traquair, of Edinburgh, and the Bigsby Medal to Mr. G. W. Lamplugh, of the Geological Survey. The Wollaston Fund to Mr. A. W. Rowe, the Murchison Fund to Mr. T. S. Hall, of Melbourne, and the Lyell Fund to Dr. J. W. Evans and Mr. A. McHenry. The president delivered his anniversary address, which dealt chiefly with the evolution of ideas during the nineteenth century as to the genesis and classification of igneous rocks.

DURING the last fortnight an interesting series of letters on the audibility of the minute-guns at Spithead has appeared in the *Standard*, and several correspondents refer to other instances of the reports of guns being heard at great distances. The firing at Waterloo is said to have been heard at Heathfield (Sussex), as well as at Sandgate, Hythe and Ripple Court (between Dover and Deal), at Sandgate very heavy firing being heard throughout the day to the eastward. Heathfield is about 184 miles from Waterloo, Sandgate 144, Hythe 147 and Ripple Court 135 miles. Accounts are also quoted from Pepys' Diary on the sounds of the battle of Solebay being heard in London (about 100 miles), and, from the *Gentleman's Magazine*, of almost incessant heavy firing from Tournay being audible at Brean, Waltham, Brabourne and on other high lands in Kent (about 110 miles), and from the bombardment of Valenciennes at Dover (about 110 miles).

WE have received from Messrs. Lever Bros., Ltd., a translation of a report (which appeared in the *Strassburger Post*) of a lecture on wireless telegraphy, delivered by Prof. Braun at the Institution of Physics of the Emperor William University. Prof. Braun, after giving a short account of the history of the subject, proceeded to describe a system of wireless telegraphy which he had himself worked out. Instead of having a spark gap in the vertical wire, this wire is coiled at its lower end and oscillations are set up in it by induction from another coil containing the spark gap in which the oscillatory discharge takes place. This method, the lecturer claimed, is in many ways superior to that adopted by Marconi, and enables messages to be sent with more certainty and to a greater distance. The results of experiments that had been made were quoted, in which messages were transmitted a distance of about seventy-five miles, using masts ninety feet high at each end. Experiments on the Marconi system are compared with these, in which the results are certainly not so good as those obtained by Prof. Braun. We may, however, call attention to the announcement made by Prof. Fleming to the Liverpool Chamber of Commerce last week (p. 381) that Mr. Marconi had succeeded in transmitting messages a distance of 200 miles, and that messages could be sent simultaneously in both directions, and two or more could be received at once at each station. These results are extremely good, especially as they show that the difficulties of interference of one message with another have been partially, if not wholly, got over. We do not learn from the report of Prof. Braun's lecture whether he has succeeded in avoiding these difficulties in like manner.

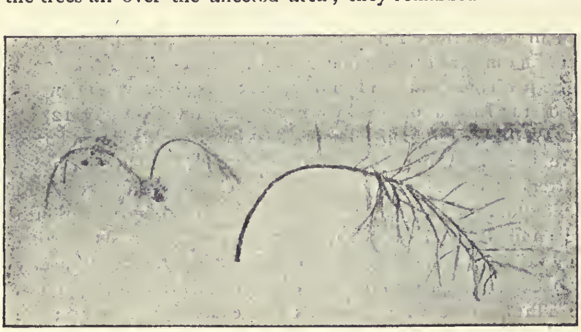
THE Government of New South Wales knows how to appreciate scientific information, and use it for the good of the Colony better than some Governments nearer home. A number of excellent pamphlets on the natural resources and industries in New South Wales have been prepared by Mr. T. A. Coghlan, Government Statistician, and distributed by the Agent-General for the Colony. A pamphlet on the timber resources shows that few countries have such a wealth of timber as New South Wales. Its woods are as varied as they are valuable, ranging from the ironbarks, unsurpassed for work requiring hardness and durability, to the kinds suitable for the most delicate specimens of the cabinet-maker's art. Forestry is, however, as yet only in its initial stages in New South Wales, though it is hoped that a School of Forestry will be established in the Colony before long. The importance attached to the diffusion of knowledge of agriculture is evidenced by the existence of a special Department of Agriculture. The central establishment possesses an experimental farm having a total area of 3430 acres, in addition to which there are several other large experimental farms and plantation trial stations. The agricultural position and outlook of the Colony are described in a separate pamphlet. Another pamphlet, on the climate of New South Wales, contains a large map of Europe having upon it the names of towns in the Colony placed beside European towns of corresponding mean temperature. Bourke, for instance, is placed by the side of Messina, Bathurst with Bordeaux, Cooma with Ventnor, and Kiandra with Edinburgh. Two other pamphlets deal respectively with the fauna and the mining industry of New South Wales. The whole series is commendable, and New South Wales is certainly to be congratulated upon the publication of so much valuable information concerning its resources and progress.

THE Nilgiri Railway is notable as being the first Abt-rack railway constructed in India, and, at present, the longest of its class in the world. It is, moreover, the first for which all the plant and material was manufactured in England. An account of the permanent way and rolling stock was given at the meeting of the Institution of Civil Engineers, on February 12, by Mr. W. J. Weightman. The railway was chiefly designed to serve the important towns of Ootacamund, the summer headquarters of the Madras Government, Coonoor, Kotageri and Wellington, the latter being the military sanatorium for South India and Burmah. It is 16¾ miles long, and from its starting point at Mettapollium on the Madras Railway, ascends nearly 5000 feet to the plateau on the Nilgiri Hills. The first 4¾ miles are adhesion-line with gradients not exceeding 1 in 40; the remaining 12 miles are built on the Abt-rack system, and have a ruling gradient of 1 in 12½. The formation-width is everywhere 16 feet, and as the rainfall is frequently 6 inches in as many hours, the greatest possible care has had to be taken to see that it is effectually drained. The locomotives are of the type known as "combined" Abt engines, that is, they can run either on rack or on ordinary line. Before the line was opened for traffic a series of brake experiments was made with a fully loaded train of 100 tons gross weight. With an ascending train at speeds of 6, 8 and 10 miles per hour on a 1 in 12½ gradient, stops were made in 24, 36 and 60 feet respectively; with a descending train at various speeds ranging from 4 to 12 miles per hour, relative stops were made in 54 feet, increasing to 425 feet.

A NUMBER of designs of flying machines have recently appeared in the illustrated papers. The *Graphic* for January 12 contains a figure of a kind of combination of ice boat and flying machine, attributed to an Austrian engineer named Kress. The arrangement of the aerocurves one behind the other would appear, according to Chanute's experiments, to detract from the lifting power of the hind ones. In the *Black and White Budget* for January 26 occurs the figure of a so-called "auto aviator," due to M. Firman Boussan. It is said to be surmounted by a vertical oblong balloon, thus resembling Dr. Danilewsky's balloon, to be provided with curved wings and propellers, and to be provided with wheels by which it can run

on the roads. Mr. G. L. O. Davidson's name has also recently figured in several papers in connection with the problem of artificial flight, and illustrations of one of his models appear in the *Scientific American* for February 2. The model in question is a bird-shaped glider, the tail of which has movable parts provided with automatic mechanism for regulating the balance and stability. It appears to have glided satisfactorily, but we do not gather from the journal in question that Mr. Davidson has himself performed glides through the air or experimented with motor-driven models. M. Santos Dumont has been experimenting with a motor-propelled balloon, weighing altogether not more than 250 pounds; but the only performance of which we have read consisted in the maintenance of a relative velocity of seven miles an hour for half a minute.

DURING a severe sleet-storm over a large tract of the northern United States, including Missouri, the water froze as it fell, forming such a heavy coating of ice upon the trees that many of them were bent to the ground by the load, as shown in the accompanying illustration from a paper by Dr. H. von Schrenk, in the *Transactions* of the Academy of Science of St. Louis. The tree in the foreground is a soft maple (*Acer dasycarpum*), likewise the row of trees of which it is one. The trees at the left are birches (*Betula alba*). The tops of the maples scraped on the snow of the street, and is was impossible for one person to lift the top of a tree, much less to restore it to its original position. These trees are good instances of the appearance ot the trees all over the affected area; they remained in the bent



position until the ice melted a week later, when the maples returned nearly to their original position and the birches stood quite upright as they were before the storm. Dr. Schrenk weighed about two hundred branches, taken from various trees, and he found that the ice-coated branches of the maples were nearly ten times heavier than the same branches without the layer of frozen water upon it. When the branches bore icicles the ratio was much greater, in many cases the weight being about thirty times greater than that of the branches without ice.

DR. E. LEYST has published in the *Bulletin* of the Imperial Society of Naturalists of Moscow an elaborate discussion of the daily range of barometric pressure at that place deduced from hourly observations, and has compared the results with those obtained from earlier observations and with observations made at St. Petersburg. The values of the harmonic analysis coincide generally with those deduced in the laborious discussions of Dr. Buchan and Dr. Hann. One of the important points of the discussion is the conclusion that the daily range at Moscow appears to have undergone a secular change in so far that the extremes of the daily curve occur earlier than was the case some thirty or thirty-five years ago.

THE vitality of certain micro-organisms, both pathogenic and otherwise, in milk under various conditions, forms the subject of an elaborate memoir by Messrs. F. Valagussa and C. Ortona, of the Hygienic Institute of the University of Rome, published in the *Annali d'Igiene Sperimentale.* The action of sunlight on bacteria in milk was investigated, and, as was only to be expected, in consequence of the opacity of the liquid no deleterious effect was detected, except in the case of those varieties which live on the surface of liquids and were, therefore, not shielded from the bactericidal action of sunshine. Another point of interest investigated was the effect of its inoculation into milk upon the elaboration of toxins by the diphtheria bacillus. It was found that although this bacillus does produce toxin when growing in milk, its strength is less than when grown in other culture-media; moreover, a marked increase in the strength of the toxin was noted when the cultivations were kept in a cool cellar instead of at the ordinary temperature of the laboratory. The exact thermal death-point of the tubercle bacillus in milk was also reinvestigated, this being a matter on which many different opinions are held. The authors state that exposure to a temperature of 60°, 70° and 80° C. is insufficient to guarantee the destruction of this bacillus in milk. Milk freshly drawn from the cow, with precautions ensuring its sterility, was found to afford a better culture material for bacteria than after it had been artificially sterilised by heating to 100° C. The paper is rendered of additional value by the very carefully compiled bibliography of the existing literature on the subject which is appended, and which makes it of special use to all interested in this section of dairy-bacteriology.

A PAPER on hermit-crabs allied to *Pagurus bernhardus*, by Mr. J. E. Benedict, is published in vol. xxiii. (pp. 451–466) of the *Proceedings* of the U.S. Museum, and is noteworthy on account of the excellence of the illustrations. Many of the forms described are closely related, but, in the absence of intergradation, they are classed as species rather than races.

Bulletin No. 14 of the Biological Division of the U.S. Department of Agriculture is devoted to a digest of the laws regulating the sale and transport of game in the different States of the union, the authors being Messrs. T. S. Palmer and H. W. Olds. All the States, it appears, are now fully convinced that unless stringent regulations are put in force the game animals and birds of America will ere long disappear for ever. It is satisfactory to learn that every State has now established laws bearing upon the preservation of game, although more general harmony between them might be advantageous. In their preface the authors state that an Act of Congress passed in May last supplements previous laws by prohibiting the shipment from one State to another of birds killed in violation of local laws, and by subjecting birds brought into any State to the regulations affecting native-raised specimens. The need of a compilation epitomising and contrasting the various laws and regulations has been much felt, and this want the present pamphlet endeavours to supply.

THE first three numbers of the new volume of *Die Natur* contain a full report of a lecture delivered in November last before the Verein zur Verbreitung naturwissentschaftlicher Kenntnisse in Vienna, by Prof. F. Toula, on the geological history of the Black Sea. The succession of events, beginning doubtfully in the lower or middle Oligocene, and with certainty in the uppermost Oligocene, is traced through nine distinct stages. The paper forms a most useful summary of recent research over an area including much of the eastern Mediterranean, and extending northward and eastward into Russia and Siberia; a considerable proportion of the work, especially that of Russian geologists and hydrographers, being not easily accessible.

ACCORDING to the *American Museum Journal* for December the search for fossil vertebrate remains in the far West is being prosecuted with as much activity as ever. Fourteen large cases of

mammalian remains from the Upper Tertiary of Texas, and several truck-loads of dinosaurian bones from the Jurassic of Wyoming and the Cretaceous of Dakota have reached the Museum as the result of last season's work. The dinosaurian remains include the skeletons of one large carnivorous form and of another more nearly allied to the iguanodon. In the same journal will be found an account of the collections in the geological department of the Museum and the manner in which they were acquired. The first important acquisition was the Holmes collection from the Tertiary of South Carolina; this was followed, in 1875, by the James Hall collection, which at once placed the Museum in the foremost position among American institutions in regard to Palæozoic fossils.

PROF. PENCK contributes a valuable paper to the *Zeitschrift* of the Berlin Gesellschaft für Erdkunde, on the glacial phenomena of Australia. The evidences of glacial action in different parts of Australia during permo-carboniferous times are discussed in detail, and brought into relation with traces of simultaneous action in India and South Africa; and it is shown that, apart from other difficulties, the hypothesis of a shifting of the South Pole to a central point (on the tropic of Capricorn in long. 86° E.) does not satisfactorily account for the geological facts. It is next pointed out that the appearances ascribed to ice action present in each case certain features not characteristic of ordinary glacial deposits—the deposits are stratified, and the pebbles are facetted in the manner first described by Wynne. Further, the Gondwána beds, always closely associated with these boulder deposits, have lately been found in the Argentine Republic. Prof. Penck compares the bedding and facetting with conditions induced by pressure observed in the Nagelfluh and in certain localities near Vienna, and concludes that while many indications certainly point to glacial action, these special points must be fully investigated before the formidable problem of accounting for the existence of glacial conditions over such an enormous area can be attacked. The second part of the paper summarises present knowledge of the quaternary glacial, or glacier, period in Australia and New Zealand, and compares the probable elevation of the snow-line in Australia and western Europe in quaternary and modern times.

MESSRS. J. J. GRIFFIN AND SONS have just introduced a new form of balance which should find a place on many lecture tables. The instrument is large enough to be seen clearly by a large class, and it can be manipulated by the lecturer without standing in front of it. The sensitiveness, rate of swing, length of arm and other characteristics can be altered so as to illustrate the principles of construction of a balance.

A PAPER by Messrs. K. A. Hoffman and E. Strauss on "radioactive lead" appears in the current number of the *Berichte*. This material is extracted from various minerals such as pitchblende, cleveite, broggerite, copperuranite, samarskite and euxenite, and resembles lead in being precipitated from its acid solution by sulphuretted hydrogen, in forming a sulphate insoluble in dilute sulphuric acid, and in having a yellow iodide. It differs from lead in the fact that it acts upon a photographic plate in the dark; it possesses a characteristic violet line in its spark spectrum, and its equivalent is markedly different, being 65·05 as against 51·7 for lead. The authors regard their results as being due to the presence of an element of an atomic weight of over 260, probably either divalent or tetravalent.

IN a recent contribution to the *Proceedings* of the American Academy of Arts and Sciences, Prof. Richards, of Harvard, expresses the opinion that the formal sanction of an international table of atomic weights is only a matter of a short time. The opinion elicited by the Commission of the German Chemical Society is overwhelmingly in favour of $O=16·00$ $(H=1·01)$ as against $H=1$ $(O=15·88)$, though some eminent authorities would adhere to the old standard. The second question put by the German Commission, as to whether the last figure set down in an atomic weight should be correct to within half a unit, is also answered in the affirmative by a large majority. From this consensus of opinion Prof. Richards is a dissentient, and he explains his position by reference to the case of nitrogen. The International Committee constituted through the German Chemical Society appears already to have made its decision, for in the first number of the *Berichte* for the present year there are inserted two tables of atomic weights, one of which is headed "Internationale Atomgewichte." In this the basis is $O = 16·00(H = 1·008)$, and the numbers given are accurate to one unit in the last place. The second table issued with the *Berichte* is of "Didaktische Atomgewichte" to the basis $H = 1·00(O = 15·88)$. It is obviously intended to meet the objections of teachers who foresaw difficulties in having to explain the use of 16 as the basis of a numerical system for atomic weights and densities. Opinions will differ as to the wisdom of having two tables current, but in any case they need not both be adopted by the same person. It would be hard for a teacher to have to remember that in the class-room S was 31·83, whilst in the laboratory it was 32·06. It is probable that most didactic requirements will be satisfied with $S = 32$.

THE additions to the Zoological Society's Gardens during the past week include a Common Guinea Fowl (*Numida meleagris*) from Morocco, presented by Mr. G. E. Veroutsos; fourteen Tree Frogs (*Hyla*, sp. inc.) from Barbadoes, a Capuchin (*Cebus*, sp. inc.) from South America, a Black-handed Spider Monkey (*Ateles geoffroyi*) from Central America, two Blood-rumped Parrakeets (*Psephotus hoematonotus*) from Australia, deposited; an August Amazon (*Chrysotis augusta*) from Dominica, four Banded Grass Finches (*Poëphila cincta*) from Queensland, two Arizona Heloderms (*Heloderma suspectum*) from Arizona, U.S.A., purchased.

OUR ASTRONOMICAL COLUMN.

REDUCTION OF OBSERVATIONS OF EROS.—In anticipation of the conclusion of the work on the planet Eros during the recent opposition, Prof. G. C. Comstock, of Washburn Observatory, U.S.A., contributes a note to the *Astronomical Journal*, No. 490, on the limits available in the necessary reductions. The question of reducing micrometer measures depends on the degree of accuracy with which it may be assumed that the mean of a number of settings represents the positions of the planet and comparison stars at the mean of the observed times. The problem is discussed with respect to three independent sources of changes in the observed coordinates.

(*a*) *Geocentric motion.*—General result is that if a set of measures does not extend over a period greater than one hour, the planet's motion may be treated as uniform, with a probable error of $\pm 0''·01$.

(*b*) *Parallax*, which changes with the observer owing to the diurnal motion. In this case the interval allowable is less than half an hour.

(*c*) *Differential refraction*, varying with the time of observation. For this element a table is given showing the correction introduced for varying zenith-distances.

CONSTANT OF ABERRATION.—The results of zenith-telescope observations of latitude at the Flower Observatory, University of Pennsylvania, are given by Mr. C. L. Doolittle in the *Astronomical Journal* (No. 490).

The correction to Struve's aberration constant was determined from these observations and applied to the final reductions. The following values of the constant have hitherto been derived:—

1892–1893	...	$20''·552$	...	at Bethlehem.
1894–1895	...	20·537	...	,, ,,
1896–1898	...	20·580	...	,, Philadelphia.
1898–1900	...	20·542	...	,, ,,

HARVARD COLLEGE OBSERVATORY.

THE fifty-fifth annual report of the work done at the Astronomical Observatory of Harvard College during the year ending September 30, 1900, has recently been circulated by the Director, Prof. E. C. Pickering, and is here summarised.

Observatory Instruments: *East Equatorial.*—The observations with this instrument were made by Prof. O. C. Wendell; during the year 24,000 photometric light-comparisons were made, principally with the achromatic prism polarising photometer. Over 15,000 of these were series of measures of twenty variables.

This instrument, with a second photometer adapted to stars nearer together, has been used for determination of the following:—

	Comparisons.		Comparisons.
o Ceti	1792	β Lyræ... ...	848
U Camelopardali.	160	Nova Aurigæ ...	96

and also in the photometric measurement of Jupiter's satellites while undergoing eclipse, eighteen eclipses having been observed; the satellites of Saturn, Japetus and Titan; the light of the planet Eros (224 settings), and in addition the systematic photometric observations of variable stars of long period have been continued.

Meridian Circle.—The ruled glass plate with which former determinations have been made for the last ten years has been replaced by spider lines, and the declination micrometer employed in conjunction for the first time. From the new observations a comparison is to be made between the accuracy obtainable by the two methods. The work of the instrument has been mainly confined to determinations of clock error and instrumental constants. The reduction of the observations made by the late Prof. Rogers from 1879–1883 is being continued.

12-inch Meridian Photometer.—With this instrument 79,024 settings were made by the Director on 140 nights. The first large work, comprising the observation of all the stars contained in the Durchmusterung, in zones 10′ wide and 10° apart, is now practically completed; the total number of stars is 9233, 6195 of which are fainter than the ninth magnitude. Good progress has been made with the reductions.

Meridian Photometer.—The observations of the stars south of declination −30°, of magnitude 7·0 and brighter, were completed early in December at Arequipa. Forty-four series were taken, involving 13,244 settings. The instrument was then sent to Cambridge, mounted, and electric light substituted for gas. A catalogue of standard stars, one in each 10° square, has now been prepared, and 16 series, including 6424 settings, have been made by Prof. Bailey.

Henry Draper Memorial.—Six hundred and eighty-nine photographs have been obtained with the 11-inch Draper telescope, and 2187 with the 8-inch instrument. The examination, by Mrs. Fleming, of the spectra on these plates and on those taken with the Bruce and Bache telescopes has led to the discovery of fourteen new variable stars, ten of which contained bright hydrogen lines in their spectra, and six are gaseous nebulæ. Eight variables have also been discovered in other ways. A new star in Aquila was found from examination of photographs, making the sixth object of this class detected in this manner.

In the study of the spectra of bright southern stars, it has been found that Hβ is bright in A.G.C. 8991, and variable in the two stars A.G.C. 19737 (η Centauri), and A.G.C. 20,878 (κ^2 Apodis).

Experiments are in progress for determining the photographic magnitudes of stars by the measurement of images out of focus, whereby a comparison is made of *surfaces* instead of *points*. It is found that stars can be measured in this way at the rate of five a minute, with a probable error of a tenth of a magnitude. Some 14,000 measures have been made in this way. For special purposes, charts are now being regularly taken with the 8-inch and 11-inch Draper telescopes, without following, by varying the rate of the clock and the position of the polar axis. A small telescope is rigidly attached to the base of the 11-inch telescope and directed toward two distant scales placed at right angles to each other, thereby permitting the axis to be set in any desired position rapidly and accurately. A photograph of the planet Eros was obtained in this manner on July 28, 1900, in which the image was sensibly round, although the exposure lasted 153 minutes.

Photographs of star occultations and eclipses of Jupiter's satellites have been obtained on several occasions.

Boyden Department.—As the sky was so clear at Arequipa during the latter part of 1899, it was unnecessary to remove the meridian photometer to the Desert of Atacama, Chile, as had been anticipated. Great delay has been experienced in the transmission of the plates to and from Peru, partly due to the quarantine consequent on the prevalence of fever along the west coast. The number of photographs taken with the 13-inch Boyden telescope is 201, and with the 8-inch Bache 2054.

Three hundred and fifty-eight visual observations of 48 southern variables have been made by Argelander's method. Systematic examination of all the stars south of declination −30°, between the magnitudes 6·3 and 7·0, inclusive, for the detection of new double stars, has been continued; 541 stars have thus been examined, leaving a further 450 requiring observation.

Meteorological Observations.—Observing stations have been maintained during the year at eight localities having altitudes varying from 100 to 19,200 feet; but great difficulty has been experienced at the lofty mountain stations.

These observations have now been continued for eight or nine years; taking into consideration, however, the striking uniformity of conditions which prevail in different years in this region, it is probable that additional observations would not greatly increase knowledge, and it has therefore been decided to suspend the meteorological observations of all the stations, except those at Arequipa. This seems to be a great pity, for nine years is a very short period when meteorological data are in question, and especially when the altitudes of the stations are so different.

The Bruce Photographic Telescope.—Seven hundred and sixty plates have been taken with this instrument during the year. From 319 of these 198 new faint nebulæ have already been detected. On these plates thus examined have also been found 92 asteroid trails and 2 meteor trails. In the spring of 1900 successful photographs of Eros were obtained by a special method when the object was too faint for ordinary procedures. The photographic plate was moved during exposure at the rate calculated for the motion of Eros relative to the diurnal motion. Three good plates were thus obtained on April 28, 30, 31, 1900.

A long series of photographs of Saturn was taken, to determine, if possible, the orbit of the satellite Phœbe. From an examination in Arequipa the existence of this object has not been confirmed; a careful examination will again be made on the arrival of the plates at Cambridge.

Blue Hill Observatory.—The chief work here has been the continuation of the exploration of the upper atmosphere by means of self-recording instruments carried by kites. The greatest height attained was 15,800 feet.

Miscellaneous.—(1) The scheme of distribution of important astronomical news is now greatly appreciated. Twenty bulletins have been issued during the year. These are sent gratuitously to all who desire them, and telegrams will be sent on payment of official fees.

(2) The long focus telescope obtained last year, with aperture of 12 inches and focal length of 136 inches, was lent to Prof. Langley, of the Smithsonian Institution, for photographing the corona during the eclipse of the sun in May 1900, the results being highly satisfactory.

(3) By the aid of an appropriation from the Rumford Fund of the American Academy, an important investigation has been started for the determination of standards for faint stellar magnitudes. For this work telescopes of 40, 36, 26, 15 and 12 inches aperture will be used, by the generous co-operation of the Yerkes, Lick and McCormick observatories with that of Harvard.

(4) A considerable number of photographs of the planet Eros have been taken, but as it is considered that the present opposition will not afford improved values of the solar parallax, it is doubtful if they will all be measured, unless the number obtained elsewhere be insufficient. Considerable care will, however, be taken in determining the variations of the light of the planet, both photographically and visually.

Establishment.—Prof. Pickering marks the completion of the work of the Observatory for the nineteenth century by giving a detailed account of the needs of the institution and the conditions of those portions of its work which are at present unfinished. The annual income is nearly 10,000*l.*, but this is required for current expenses. The estimated value of the buildings and instruments at Cambridge is about 15,000*l.*, and at Arequipa about 12,000*l.*

The main building at Cambridge is of wood, more than fifty years old, and the whole, including the invaluable astronomical library, is in constant danger of destruction by fire. The estimated cost of new modern buildings is about 20,000*l.* A large telescope for work at present entirely neglected in the southern hemisphere could also be obtained for a further 20,000*l.*

A long list of the principal unpublished investigations is given, most of which are ready for completion if means be forthcoming. These will occupy about twenty-eight volumes of the *Annals*, *i.e.* almost two-thirds as many as have already been published during the half-century of the existence of the Observatory.

SCIENCE IN TECHNICAL AND PREPARATORY SCHOOLS.[1]

EDUCATION is probably more discussed at the present time than ever it was before. It has become a subject for the newspapers, and to some extent for the political platform. It would seem there is now really a hope that the ordinary man of affairs will soon appreciate its importance. The advocates of education in science and technology have for years appreciated the reality and understood the reason of successful foreign competition, and now the lesson is being impressively driven home to every manufacturer by the tale of diminishing exports. Facts such as these give the recent report, made for the Department of Special Inquiries of the Board of Education by Mr. James Baker, on technical and commercial education in East Prussia, Poland, Galicia, Silesia and Bohemia, a very high value. Written as it is from the point of view of a skilled observer generally interested in the development of British industry and commerce, the report will receive more careful attention from the practical men engaged in manufacture than would the opinion of a mere student of pedagogics.

With the exception, perhaps, of the part of Russia he visited, though even there some progress is being made, Mr. Baker tells of the rapid advances he found have taken place everywhere in the development of technical and commercial education. And, what is of particular importance to us in this country, he demonstrates that the efficiency of any nation's supply of technical instruction in its various grades depends directly upon the satisfactoriness or otherwise of the national supply of primary and secondary education. It is that student alone who has received a thorough and suitable grounding in preliminary subjects who benefits by the specialised instruction of the trade school and technical college.

But this cause by itself is not sufficient to explain the high standard of foreign systems of technical education. In Prussian Poland and in parts of Austria the want of continuity between the work of the day schools and the higher technical studies of the trade schools has been abolished by legislation. In this country attendance at school during the years of apprenticeship is optional, with the result that even if the young workmen ever reach the classes specially designed to instruct in particular industries they have forgotten completely, by that time, their elementary knowledge; in the countries named, however, attendance at evening continuation or other schools is as compulsory as that at the ordinary day school. For instance, in describing the provisions for technical instruction at Posen, a town of 100,000 inhabitants in Prussian Poland, Mr. Baker writes of the Fortbildungsschules (continuation school, and the Gewerbschule or trade school: "This is for learners in all handicrafts. There is no payment, but the apprentices in all trades are compelled to attend this school under penalty of fine or even imprisonment. Lads commence here at fourteen and continue until eighteen, attending two afternoons a week and in the evenings. The employers are compelled to give their apprentices two afternoons a week, unless they are engaged upon work outside the town, when the lads are excused from attendance." Similarly, in connection with Trautenau, the Bohemian flax centre, with 16,000 inhabitants, we find: "Here all the apprentices must attend the trade continuation classes, which are held from six to eight in the evening and from eight to twelve a.m. on the Sunday. . . . In the Commercial Continuation School the same applies to business apprentices." And similar examples could be multiplied.

But it is impossible to manufacture, by any system of compulsion, enthusiastic students anxious to master everything known about the science of their trade and filled with a desire to improve upon the methods generally adopted. Continental authorities recognise this. It may be possible to raise the average ability of the workmen by enforced attendance at evening schools, but to discover the specially endowed craftsman who will repay all the trouble taken to place opportunities in his way, other plans are adopted. Here is one, expressed in Mr. Baker's words: "There is one great leverage the German schoolmaster possesses wherewith to lift his pupils into good work that an English teacher does not possess, and that is the fact, if a certain grade of work is passed, the student is freed from one or two years of military life, becomes a 'volunteer,' and only serves one year." But it is only in exceptional cases that this rule applies in Austrian towns, at all events in the lesser towns. Another means of attaining the same object is very common. In those schools which have not the right to exempt their pupils from one year of military service, an *Ausweis*, or leaving document, is employed, and on this is set forth the progress made, the behaviour and the diligence of the pupil, with a record of the attendance and a list of the subjects studied by the young man. This record has to be produced when the youth is called up for his time with the colours, and if the report is bad he may have to serve three years instead of two.

This subject of compulsory military service brings into high relief one great advantage the British workman has over his Continental contemporary in point of time. Mr. Baker writes eloquently in this connection: "In going through these technical schools I saw young men working at the most delicate handicrafts; they had just arrived at excellency; their skilled hands, guided by a highly cultured brain, were turning out work most delicately artistic; but they must lay down their tools and take up sword and rifle for two years, or three if in the cavalry or artillery; their hands must forego the exercise of their cunning, if they do not lose it altogether; . . . Herein is the Englishman's opportunity when he obtains the same advantages of education as the Austrian or German; he can at once leap ahead of his Continental competitor, for he gains these two years given up by the Continental to military service."

But perhaps the most remarkable characteristic of Austrian technical education is the extent to which decentralisation has been carried throughout the country. While making due provision for advanced work in a few large centres, the object of the authorities seems to be to bring suitable instruction in the technology of the particular industry of a district to the very doors of the workers. A notable instance of this, and it is typical, is the case of Turnau, or Turnov, the jewellers' town. It is a little place of 6500 inhabitants, whose chief industry is goldsmiths' work and the polishing and setting of jewels. Here has been established a Royal Imperial trade school for jewel cutting, polishing, engraving and setting in gold, but in addition to this technical institute there are four Volksschulen (primary schools), a Bürger school, and a continuation school in winter for handicraftsmen. The students of the Royal Imperial trade school come direct from the Volksschulen, beginning this special work at fourteen and remaining for four years. The tuition is free, but the lads receive no pay. The total number of pupils in the school is seventy-eight, and they are all being converted into cultured artisans. When they pass out of the school they are given a leaving certificate, which confers the full status of a workman and ensures treatment as an educated man for the holder.

The question naturally presents itself, What manner of men are in charge of institutions the object of which is to produce accomplished artisans who are also at the same time educated in a higher and more general sense? On this subject, too, the report under consideration supplies abundant information. In the description of the technical college at Prague a short life-sketch of Director Edward Cerny is given. He bears the title, by the way, of Royal and Imperial Councillor—a proof of the esteem in which men of science and educational leaders are held in Austria, where, as in Germany, such authorities are commonly nominated Privy Councillors, and receive titles and decorations. It is impossible in a short article to refer to all Director Cerny's qualifications; it must suffice to say that his case is quite general and that the common rule is to appoint

[1] Report on Technical and Commercial Education in East Prussia, Poland, Galicia, Silesia and Bohemia. By James Baker, 122 pp.
Board of Education Special Reports on Educational Subjects. Volume vi. Preparatory Schools for Boys: their Place in English Secondary Education. 531 pp.

"practical engineers or business men, thus bringing to bear on their teaching, not only the general education gained at school and their thorough knowledge of theoretical science, but also their practical experience of the workshop and business life."

These are but a few of the vital questions with which this valuable report is concerned. We heartily commend the volume to all who are interested in improving the home supply of technical education until it is not only on a level with that of Germany and Austria, but well in advance.

When we turn to the second of the reports, that concerned with the place in English secondary education of preparatory schools for boys, we are confronted with another stage in the preparation of the citizen for the duties of life. As every one knows, probably, the preparatory school undertakes the education, up to about fourteen, of the boy destined for our great public schools. Generally, after some five years at the public school, this fortunate son of well-to-do parents proceeds to either Oxford or Cambridge to continue his education. It is interesting to inquire as to the share science takes in the work of a preparatory school. It may be stated parenthetically that in a volume of 531 pp. only some sixteen pages are devoted to the teaching of mathematics and natural science together, though it is true nine of the sixteen are given to the latter.

It must be said at once that any science teaching at all in preparatory schools is the exception rather than the rule. To quote Mr. Archer Vassall, of Harrow, who deals with the subject in the official publication before us, "tentative efforts in scientific instruction have been made, and are still in progress at many of them"—and that is all that can be said. But there is nothing surprising about this. Since the sole function of the preparatory school is to prepare for the public school, those subjects only which are in demand in the second will be taught in the first, and, to quote Mr. Vassall again, "in public schools the teaching of science has only recently begun to take reasonable shape," a condition brought about by the regulations governing the award of University scholarships. So that to ensure an improved condition of things in the preparatory school men of science must bend their efforts towards securing reforms at Oxford and Cambridge.

Mr. Vassall's short article is chiefly concerned with a sketch of a suitable preparatory school course in natural science. In common with modern ideas he insists upon the need of individual practical work, and very properly urges that the study of science might well begin with what he calls "kindergarten physics." This mode of procedure has for some years been followed in higher grade boards schools, and in those other secondary schools which have adopted the syllabus of the Headmasters' Association. But we think Mr. Vassall is wrong in excluding chemistry from his preliminary course, for there are many excellent exercises which are in no way dangerous. Anyhow, a beginning has been made with science in preparatory schools, and if the masters will acquaint themselves with the results of experience in schools of other grades, we shall soon hear that science has gained for herself a more honourable place.

A. T. SIMMONS.

THE FIGURE OF THE EARTH.[1]

THE United States Coast and Geodetic Survey has just published a quarto volume containing an account of the transcontinental triangulations and measurements of an arc of the parallel in latitude 39°. It also has ready for publication the manuscript giving the result of an oblique arc in the eastern part of the United States. Both are contributions of great length and among the first of their kind in America.

Before entering upon the detail of the two arcs it may not be out of place to state that in order to obtain a measure of the dimensions of the earth, as represented by a spheroid, that is, by a surface generated by the rotation of an ellipse about its minor axis, it is essential that we should be in possession of at least two arcs or of an equivalent thereof. For combinations of two arcs of the meridian, their mean latitudes should differ widely; the same is true for the combination of two arcs of the parallel. We may also obtain an arc of the meridian with one of the parallel, but in every case the measures should be of considerable extent. Arcs of less than 5° (about 556 km., or 345 st. miles) would now be regarded as short ones. It has been stated that one of the arcs is an oblique arc, and as it possesses a great range of latitude and also of longitude and is supplied with a large number of astronomical measures, it is of itself sufficient for the deduction of values for the dimensions of the earth. Furthermore, it may be remarked that for any relatively small part of the earth's surface an osculating spheroid may be determined, as, for instance, was done for our oblique arc. Such a spheroid has the property that its surface is in best accord, as regards curvature, with the actual or physical one, the latter considered as a mathematical surface of equilibrium and generally known as geoid.

The definition of an osculating spheroid thus implies that the sum of the squares of the difference between the various astronomic and geodetic measures be a minimum. The mathematical treatment of the combination of the arc measures differs according to their nature, whether they are extended in a certain direction or whether large areas are covered, but in its generality it is necessarily laborious.

The salient points of the two arcs measured by the U. S. Coast and Geodetic Survey and the results reached may now be briefly stated. First, the arc of the parallel in latitude 39°.[1] It extends from Cape May, N.J., on the Atlantic coast, to Point Arena, Cal., on the Pacific coast, and ranges over 48° 46′ of longitude, with a linear development of about 4225 kilometres, or 2625 st. miles. The triangulation is supported by ten base lines with an aggregate length of 53½ st. miles, the longest or Yolo base being 10·9 miles in length, one half of these lines having a smaller probable error of measure than one part in a million. A characteristic of the triangulation is its rigidity imparted to it by quadrilaterals and other polygons. In crossing the Rocky Mountains, many of its sides exceed one hundred miles in length, and there is one side reaching to a length of 294 km., or 183 st. miles; the altitude of many of the stations is also considerable, reaching to 4300 metres, or 14 108 feet, in the case of Pike's Peak, and to 14,421 feet at Mount Elbert. All geometrical conditions subsisting in the triangulation are satisfied by adjustment, inclusive of the required accord of the base lines, so that the same length for any given line is found no matter from what line one may start. This involved much heavy work; for instance, the triangulation adjustment between the Salina and the El Paso base demanded the simultaneous solution of ninety-nine normal equations (with as many unknowns). In addition, the figures required the evolution of a correction to each of the two hundred and twenty-five observed directions.

Coming to the astronomical measures, we have distributed over or near the arc one hundred and nine latitude stations, occupied almost exclusively with zenith telescopes; there are, also, seventy-three azimuth stations, various methods having been used, and lastly we have twenty-nine telegraphically determined longitudes. These, of course, are of paramount importance for an arc of the parallel. There cannot be too many longitude stations in consequence of that great stumbling-block in geodesy, the local deflections of the vertical or plumb-line. These deflections of the zenith from a normal direction have been divided into two groups—those which are regional or manifest themselves with marked common features over thousands of square miles, and those which are quite local and greatly depend upon the surface features immediately surrounding them.

These deflections, even in level countries, average about 2·5″; but in mountainous regions this deflection is greatly surpassed. Thus we find for deviation of the plumb-line at Patmos Head station 12″ to the north, at Colorado Springs 25″ to the west, at Salt Lake City about 17″, and at Ogden about 15″ to the east, at Genoa Station, Nev., nearly 29″ to the west, the quantities depending to some extent on the spheroid of reference; but their amount and direction are obviously well accounted for by the position of known attracting masses. In connection with this, continental attraction may manifest itself and be recognised by the astronomical amplitude of the longitudes of extreme stations of a long arc being in excess of the corresponding geodetic amplitude. The matter cannot be further pursued here in detail, but it may suffice to state that the average curvature of the equipotential surface of the geoid along the parallel of 39°

[1] Abridged from a paper on recent contributions by the United States Coast and Geodetic Survey to our knowledge of the earth's shape and size, by Mr. C. A. Schott, in the *National Geographic Magazine*, New York.

[1] U. S. Coast and Geodetic Survey; H. S. Pritchett, Superintendent. The Transcontinental Triangulation and the American Arc of the Parallel. By C. A. Schott, Assistant, Coast and Geodetic Survey, Washington, D.C., 1900.

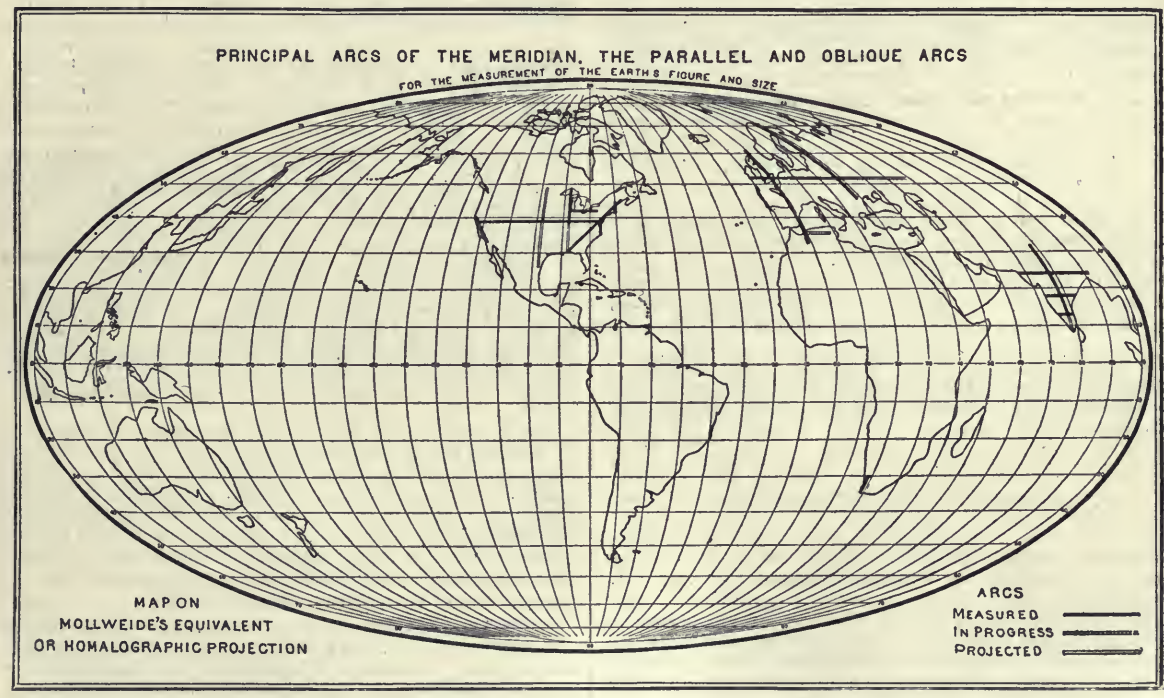
approaches for about four-sevenths of the arc from its eastern end closely to that of the Clarke spheroid; whereas, for the remaining three-sevenths, or for the region across the Rocky Mountains to the Pacific, the curvature comes more nearly to that of the Besselian spheroid. In the published paper two tables are given containing the results needed for combination with any other arc and, in conclusion, some preliminary rough combinations of American arcs are presented; all of which point to a reference spheroid of larger dimensions than those of the Besselian and are in favour of continuing the use of Clarke for reference.

The second arc under consideration extends from Calais, Me., in the north-east and opposite the Canadian boundary, to the Gulf of Mexico, and terminates at New Orleans, La. It is known as the Eastern Oblique Arc of the United States. Its length is 2612 km., or 1623 statute miles; its difference of latitude is 15° 1′, and of longitude 22° 47′. The general direction is therefore favourable, and the length ample to secure fair results for an osculating spheroid. In the main the triangulation follows the Appalachian chain of mountains; in Western North Carolina and Eastern Tennessee it bifurcates, leaving an oval space between the two branches. The length of sides depends upon six base lines, and in general the development is closely accommodated to the hypsometric and other natural conditions along the course. It includes among its stations the two highest points in the eastern part of the United States, viz. Mount Washington, N.H., rising to about 1920 metres, or 6300 feet, and Mount Mitchell, N.C., rising to about 2038 metres, or 6687 feet.

The adjustment of the whole triangulation is effected precisely as explained in the use of the arc of the parallel; the small reduction to the sea-level of the observed horizontal directions, on account of the altitudes sighted, was only applied when exceeding 0·05″. The principal labour of adjustment was demanded by the necessity of bringing into accord the measured lengths of the Fire Island, the Massachusetts and the Epping base lines, and fulfilling the geometrical conditions of the intervening net of triangles. This demanded the satisfying of fifty-seven conditions and involved the simultaneous solution of an equal number of normal equations and the working out of 131 corrections of observed directions. Of astronomical measures we have seventy-one latitute stations, seventeen longitude stations, and fifty-six azimuth stations, tolerably well distributed over the whole extent of the arc. The latitudes, as were those of the arc of parallel, were corrected for height of station or curvature of the vertical and for variation of pole according to Dr. Chandler's and Dr. Albrecht's researches. The same scrutiny as before had been extended to the deflections of the vertical, both regional and local. Partly on account of avoiding unnecessary labour, but principally on account of the crowding together of astronomical stations in certain very limited localities, and all of them, therefore, partaking of the deflections characteristic of this area, the total number of astronomical stations admitted into the final equations for the determination of the best spheroid were thirty-six for latitude, fourteen for longitude, and thirty-four for azimuth, or eighty-four conditions in all.

These eighty-four differences between the astronomical and geodetic results constitute the data needed for a new determination of a spheroid; next the functional relations between the positions of these stations upon the reference spheroid to the earth's equatorial radius and to the compression of the polar axis had to be established.

The final normal equations contain, therefore, four unknown quantities, viz. the correction to the meridional deflection of the vertical at the initial or reference station of the oblique arc; second, the corrections to the deflection of the vertical, in the plane of the prime vertical, at the same place; third, correction to the equatorial radius of the reference spheroid; and, last, the correction to its compression.



In the combination of conditional equations arising from observations of a different nature, the question of their relative weights must be considered. In the present case, four assumptions were made and the consequent normal equations solved, viz. for equal weights, for weights one-half, one-third and one-fourth to the azimuth equations, the latter being necessarily inferior to the equations derived from latitudes and longitudes. A comparison of these four results showed that it was of small consequence which of these hypotheses was finally adopted, since the corrections to the equatorial radius of the reference spheroid were practically the same for any of these hypotheses, and nearly the same could be said of the resulting compressions. The weight one-third to each of the azimuth equations was finally decided upon, and the resulting dimensions of an osculating spheroid were found to be:—Equatorial radius, 6,378,157 ± 90 metres; compression, 1/304·5 ± 1·9. The equatorial radius, therefore, differs but 49 metres from Clarke's value of 1866 adopted on the Survey, while the Besselian value is apparently too small by 809 metres. On the other hand, the compression or the ratio of the difference of the equatorial and polar semi-axes to the former is in favour

of Bessel's spheroid, of which the compression is 1/299·2; that is, one more closely approaching a sphere.

In the present state of our knowledge there is no reason to suppose that the curvature of the northern part of America differs any more from that of a general spheroid derived from arcs of all kinds so far measured than local ones in either hemisphere differ among themselves. A comparison of a number of such locally adopted spheroids will bring to evidence the local deformities in the shape of the earth's equilibrium surface and furnishes the geodesists endless material for the study of the earth's actual figure.

The manuscript concludes with a comparative table of the dimensions of several spheroids which of late have come more into prominence. It is as follows:—

Spheroid of	Equatorial radius, a, in metres.	Polar semi-axis, b, in metres.	$a-b$.	Compression $(a-b)/a$.
Bessel, 1841. From ten arcs of the meridian and total amplitude 50° 34′	6,377,397	6,356,079	21,318	1/299·15±3·15
Clarke, 1858. Special spheroid for surface of Great Britain and Ireland; range of latitude 12°, the same in longitude; seventy-five astronomic stations	6,378,494±90	6,355,746	22,748	1/280·4±8·3
Clarke, 1866. From five meridional arcs, of total amplitude 76° 35′	6,378,206	6,356,584	21,622	1/295·0
Clarke, 1880. From five meridional arcs and longitudinal measures, total amplitude 88° 59·8′ (equatorial degrees)	6,378,249	6,356,515	21,734	1/293·5
United States Coast and Geodetic Survey, 1900. Eastern oblique arc of the United States; total length, 23° 31′, and eighty-four astronomic stations	6,378,157±90	6,357,210	20,947	1/304·5±1·9
Harkness, 1891. From "The Solar Parallax and Related Constants," Washington, 1891, p. 138. From a variety of sources	6,377,972±125	6,356,727±99	21,245	1/300·2±3·0

N.B.—The ± indicates probable errors.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A valuable collection of Greek papyri from Oxyrhyncus and the Fayûm has been presented to the University library by the Egypt Exploration Fund.

Dr. A. C. Haddon, F.R.S., University lecturer in ethnology, and professor of zoology in the Royal College of Science, Dublin, has been elected to a junior fellowship at Christ's College.

THE King's Speech to the Commons at the opening of Parliament on Thursday last contained the announcement that "Legislation will be proposed to you for the amendment of the law relating to education."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 7.—"The Integration of the Equations of Propagation of Electric Waves." By A. E. H. Love, F.R.S.

The equations of propagation of electric waves, through a dielectric medium, involve two vector quantities, which may be taken to be the electric force and the magnetic force. Both the vectors are circuital; and the several components of them satisfy the partial differential equation of wave propagation, viz. $\ddot{\phi} = c^2\nabla^2\phi$, c being the velocity of radiation.

Owing to the circuital relations, certain known solutions of the partial differential equation of wave propagation are not available, for representing the components of the vectors. A very general system of *particular* solutions, which are available for this purpose, is obtained. These include solutions corresponding to two types of sources of electric radiation:—The sources of one type are similar to infinitesimal Hertzian vibrators, being related in the same way to an axis, but the dependence of the emitted radiation on time is arbitrary; the sources of the other type are obtained therefrom by interchanging the *rôles* of the electric and magnetic forces.

The general integrals of the equations would express the values of the vectors, at one place and time, in terms of their values, at other places and times. To find such integrals, we require (1) sets of particular solutions, which tend to become infinite, in definite ways, in the neighbourhood of chosen points; (2) a theorem of reciprocity, connecting the values, on any chosen surface, of two sets of solutions; (3) the limiting form, assumed by the theorem of reciprocity, when the solutions of one system have the assigned character of infinity at a given point. The solutions required for the first step are among those already found; the theorem of reciprocity is obtained by a modification of the process by which the fundamental equations can be deduced from the Action principle; and the limiting form of the theorem is found by adapting a process due to Kirchhoff. The result is that the radiation which arrives at a chosen point may be regarded as due to a distribution of imagined sources of radiation upon an arbitrary closed surface, separating the point from all the actual sources of radiation. The imagined sources are of the two types previously specified; and the directions of their axes, and the intensities of the radiation sent out from them, are determined simply and directly by the values, on the surface, of the vectors involved in the propagation of the waves.

The general theorem is applied to the problem of the passage of radiation through an aperture, and the result is utilised to determine the rate of decay of the vibrations of a condensing system. The example of a condenser, with concentric spherical conducting surfaces, the outer conducting sheet being perforated by a small circular aperture, is worked out in detail; and the results suggest that the maintenance of the vibrations depends on the screening action of the outer conductor rather than on the largeness of the capacity of the condenser.

Anthropological Institute, February 4.—Annual General Meeting.—Mr. C. H. Read, president, in the chair.—On a ballot the following were elected to office for the ensuing year:—President: Prof. A. C. Haddon, F.R.S. Vice-presidents: A. J. Evans, W. Gowland, Prof. G. B. Howes. Hon. Treasurer: A. L. Lewis. Hon. Secretary: J. L. Myres. Council: Sir T. H. Holdich, Sir C. E. Peek, Messrs. G. M. Atkinson, H. Balfour, W. Crooke, Prof. D. J. Cunningham, W. L. H. Duckworth, R. W. Felkin, H. O Forbes, J. G. Garson, E. S. Hartland, T. V. Holmes, E. F. im Thurn, A. Keith, R. B. Martin, M.P., R. H. Pye, E. G. Ravenstein, Prof. W. Ridgeway, W. H. R. Rivers and F. C. Shrubsall. After reading and discussion of the reports of the treasurer and council, the retiring president proceeded to give his address. After alluding to the death of Her Majesty Queen Victoria and paying a tribute to Lieut.-General Pitt-Rivers, an ex-president of the Institute, Prof. Max Müller, Miss Kingsley and other distinguished Fellows who had been removed by death, he went on to call attention to the progress made by anthropology, more especially in the British Empire, during the past year. A joint memorial of the Folk-lore Society and the Institute had been presented to the Government, urging the theoretical and practical importance of an inquiry into the status of native races in South Africa. In India, in combination with the census, a scheme for a partial ethnographical survey had been called into existence, over the working of which the Hon. H. H. Risley would preside. He hoped that in England we should soon have chairs of anthropology at all the important teaching

centres; Birmingham had a great opportunity of founding a professorship; at Cambridge, if a sum of 200*l.* or 300*l.* could be guaranteed for a few years, a chair could be established; this was an opportunity for an Englishman to emulate the good works of American millionaires in coming to the aid of science. Not only in respect of teaching, but also in respect of ethnographical collections and accommodation for them, was Great Britain far behind other nations. (See p. 402.)

Geological Society, Feb. 6.—Mr. J. J. H. Teall, F.R.S., president, in the chair.—On the structure and affinities of the Rhætic plant *Naiadita*, by Miss Igerna B. J. Sollas, Newnham College, Cambridge. (Communicated by Prof. W. J. Sollas, F.R.S.) This plant, the remains of which are found in Gloucestershire, was considered to be a monocotyledon by Buckman, but a moss by Starkie Gardner. Material supplied by Mr. Seward and Mr. Wickes has given the authoress ground for the belief that *Naiadita* is an aquatic lycopod, and that it is the earliest recorded example of a fossil member of the Lycopodiaceæ, resembling in proportions and outward morphology the existing representatives of the group.—On the origin of the Dunmail Raise (Lake District), by Richard D. Oldham. The conclusion arrived at is that the gap of the Dunmail Raise was formed by a river, which flowed across the hills from north to south and cut down its channel *pari passu* with the elevation of the hills. The final victory of upheaval over erosion, whereby this river was divided into two separate drainage-systems and the barrier of the Dunmail Raise upheaved, may have synchronised with a diversion of the head-waters and consequent diminution of volume and erosive power. It is pointed out that this explanation comes into conflict with previously published theories of the origin of the drainage-system of the Lake District, inasmuch as the elevation postulated seems too slow to be explicable by the intrusion of a laccolite; and that the existence of a large river crossing the area of upheaval, and the maintenance of its character as an antecedent river-valley for a long period, show that the surface was originally a peneplain of subaërial denudation, and not a plain of marine sedimentation or erosion. From this it follows that the course of the main drainage-valleys may not have been determined by the original uplift, but, with the exception of those which are old river-valleys, whose direction of flow has been reversed on the northern side of the uplift, may have been formed by the cutting-back by erosion into the rising mass of high ground—in other words, that the principal valleys of the Lake District may be subsequent, not consequent, in origin.

MANCHESTER.

Literary and Philosophical Society, February 5.—Prof. Horace Lamb, F.R.S., president, in the chair.—Mr. T. Thorp and Dr. C. H. Lees were nominated as auditors for the current year.—Prof. Flux referred to the records of a recent report on water, gas and electricity undertakings, so far as they showed the rate of return on the capital invested in each case. The rates were grouped most thickly about 3 to 3½ per cent. for each class of enterprise, more closely in the case of water and, in a less degree, of gas than in the case of electricity. The total number of undertakings contributing to the result named was 1351, and the lowness of the figure representing the most frequent rate seemed rather striking.—Mr. Thomas Thorp mentioned that he had made further progress with an instrument designed to yield a pure monochromatic image of the sun, and had been able to obtain results of an encouraging nature. He hoped to be able to perfect the instrument in a short time and to exhibit it before the Society.—Dr. George Wilson read a paper, prepared by Mr. H. Noble and himself, entitled "Note on the construction of entropy diagrams from steam-engine indicator diagrams," showing how the effect of the clearance steam may be taken account of in the ordinary pressure-volume curve, thus enabling trials of different engines to give directly comparable results.—Mr. C. E. Stromeyer read a paper on the representation on a conical mantle of the areas on a sphere, in which he showed that the representation of points on the surface of a sphere on an enveloping cone, the distance of corresponding points on sphere and cone from the vertex of the cone being equal, gives a map on the developed cone the areas on which are proportional to those on the sphere.—The president announced at the close of the meeting that April 22 had been provisionally fixed for the delivery of the postponed Wilde Lecture by Dr. Metchnikoff.

EDINBURGH.

Mathematical Society, February 8.—Note on the cooling of a sphere in a finite mass of well-stirred liquid, by Dr. Peddie.—Some inequalities relating to arithmetic, geometric and other algebraic means, by R. F. Muirhead.

PARIS.

Academy of Sciences, February 11.—M. Fouqué in the chair.—On the generation of the hydrocarbons by the metallic carbides, by M. Berthelot. From an examination of the thermochemical data concerning the metallic carbides, it is shown that the condition that an acetylide on treatment with water should give acetylene is that the difference between the heats of formation of the metallic hydrate and acetylide should be greater than 196·1 calories. This is the case with the carbides of the alkalies and the alkaline earths, but not for the acetylide of silver, and this latter compound is accordingly not decomposed by water. The cause of the production of a complicated gas mixture in some cases is also discussed from a thermochemical point of view.—Observations on the solutions of solid metals in mercury, and more generally in other fused metals, by M. Berthelot. It is pointed out that the use of the word solution to express the uniform distribution of a metal in mercury is not, strictly speaking, parallel to ordinary solution.—On precession, by M. O. Backlund. Correcting an error in a previous note.—On the specific heats of fluids, the elements of which are submitted to their mutual actions, by M. P. Duhem. It is shown that all the laws demonstrated in elementary thermodynamics for a fluid submitted to a normal and uniform pressure may be extended to a fluid the elements of which exercise any actions whatever upon each other, whether Newtonian or not.—On the photography of the solar corona in solar eclipses, by M. H. Deslandres. An account of the methods employed and the results obtained on the photography of the sun's corona during the solar eclipse of May 28, 1900.—On the theory of the satellites of Jupiter, by M. J. J. Landerer. A comparison of the results of observation with the theory of Souillart.—A new class of algebraic surfaces which admit of a continuous deformation and still remain algebraic, by M. D. Th. Egorov.—On certain transformations of Backlund, by M. Clairin.—On the theorem of Hugoniot and the theory of characteristic surfaces, by M. J. Coulon.—On a class of partial differential equations of the second order, by M. R. d'Adhémar.—On the linear partial differential forms of a system of simultaneous differential equations which are also the integrals of this system, by M. A. Buhl.—On circular arches, by M. Ribière.—On the diurnal variation of the magnetic declination, by M. Alfred Angot.—Calculation of the formula giving the law of the regular distribution of the horizontal component of the earth's magnetism in France on January 1, 1896, by M. E. Mathias.—An electric anemometer indicating at a distance, by M. Emmanuel Legrand. The motion of the vanes of the anemometer drives a small Gramme ring, the current from which is connected to a d'Arsonval galvanometer at a distance. The electromotive force produced is proportional to the velocity of rotation of the vane.—Telephonic communication by means of a wire stretched across the snow, by M. A. Ricco.—Remarks on the preceding communication, by M. Janssen.—The law of transparency of matter for the X-rays, by M. Louis Benoist. The specific opacity of a body to the X-rays is independent of its physical state, of the mode of atomic grouping and of the state of liberty or combination of the atoms. For X-rays sufficiently penetrating and homogeneous, the specific opacity of elements is a determinate and increasing function of the atomic weight, the two magnitudes being approximately proportional.—New researches on electric convection, by M. V. Crémieu. The author has repeated some of his original experiments with additional precautions, and considers it finally established that under the conditions of the experiments of Rowland and Himstedt electric convection produces no magnetic effect.—On musical impressions, by M. Firmin Larroque.—On the formation and decomposition of the acetals, by M. Marcel Delépine. The formation of acetals is a limited reaction, a state of equilibrium being set up between the alcohol, acetal, aldehyde and water. The results of experiments upon the limiting values of this reaction are given for methylal, dipropyl formal, erythrite diformal and mannite diformal.—On the elimination of methane from the atmosphere, by M. V. Urbain. Recent researches by MM. Muntz and Aubin and by M. Gautier on the amount of methane in the atmosphere, compared

with those of Boussingault, show that the proportion of this gas has not increased. Hence, like carbonic acid, it would appear to be eliminated in some way. By an extensive series of experiments, the author shows that this elimination is effected by plants.—Actions of the esters of the monobasic fatty acids upon the mixed organo-magnesium compounds, by M. V. Grignard. The use of magnesium has the advantage over the Wagner-Satzeff reaction not only in its simplicity and increased yield, but also in increased generality. Thus ethyl formate and magnesium ethyl bromide gives a 73 per cent. yield of diethylcarbinol; with isoamyl bromide of magnesium and ethyl formate the formate of diisoamylcarbinol is obtained. Diisobutylcarbinol can be prepared by the analogous reaction.—On the absorption of light by the indophenols, by MM. P. Bayrac and C. Camichel.—On the acid and alcoholic combinations of phenylcarbazide, or the urea of phenylhydrazine, by M. P. Cazeneuve.—Ketones from wood tar, by M. A. Behal. The ketone, dimethylcyclohexonone, has been isolated from the neutral oil of wood tar. Its constitution was determined by means of its oxidation products, potassium permanganate giving only acetic acid and α-levulinic acid.—On dibromo- and diiodobutane: a new synthesis of adipic acid, by M. l'abbé J. Hamonet.—Comparison between the nucleated and non-nucleated red blood corpuscle, by M. R. Quinton. From the point of view of osmosis the nucleated red blood corpuscle differs in its behaviour from the non-nucleated corpuscle, inasmuch as an equilibrium is attained in the former case with urea in solution, but not in the latter.—Blastoderm without an embryo, by M. Gustave Loisel.—Action of the total pressure on the chlorophyll assimilation, by M. Jean Friedel. The diminution of the total pressure tends to favour assimilation. When air containing carbonic acid is rarefied, the assimilation passes first through a minimum and then through a maximum.—On the tuberculisation of the potato, by M. Noel Bernard. It has been previously shown by the author that in certain plants the formation of tubers from the buds is a consequence and a symptom of the infection of the roots by endophytic fungi. Experiments are now given for the potato, confirming these views, and it is pointed out that if this conclusion is exact, it should be possible, by a rational culture of the potato, to increase the size and yield of the tubers.—On a new group of very basic rocks, by M. A. Lacroix.—New observations on the glacial period in the southern Carpathians, by M. E. de Martonne.—The transgressions and the regressions of the secondary seas in the basin of the Aquitaine, by M. Ph. Glangeaud.—Contribution to the study of subterranean waters. Isochronochromatic curves, by M. Félix Marboutin.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 21.

ROYAL SOCIETY, at 4.30.—An Attempt to Estimate the Vitality of Seeds by an Electrical Method: Dr. Waller, F.R.S.—On a New Manometer, and on the Law of the Pressure of Gases between 1·5 and ·01 millimetres of Mercury: Lord Rayleigh, F.R.S.—(1) An Investigation of the Spectra of Flames resulting from Operations in the Open Hearth and "Basic" Bessemer Processes; (2) The Mineral Constituents of Dust and Soot from various Sources: Prof. Hartley, F.R.S., and Hugh Ramage.—Notes on the Spark Spectra of Silicon as rendered by Silicates: Prof. Hartley, F.R.S.

LINNEAN SOCIETY, at 8.—On the Affinities of *Æluropus melanoleucus*, Alph. Milne-Edw.: Prof. E. Ray Lankester, F.R.S., and R. Lydekker, F.R.S.—Étude d'une espèce nouvelle de Lépapèdes: M. A. Gruvel.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—If the discussion on Mr. Mordey's paper is closed, the following paper will be read:—The Electrical Power Bill of 1900: Before and After: W. L. Madgen.

CHEMICAL SOCIETY, at 8.—(1) Isomeric Hydrindamine Mandelates and Phenylchloracethydrindamides; (2) Isomeric Benzylhydrindamine bromocamphorsulphonates and some Salts of *d-l*-Hydrindamine: F. Stanley Kipping and H. Hall.—Condensation of Phenols with Esters of the Acetylene Series. IV. Benzo-γ-pyrone and its Homologues: S. Ruhemann and H. W. Bausor.—Constitution of Bromocamphoric Anhydride and Camphanic Acid: A. Lapworth and W. H. Lenton.—The Action of Acetylchlor- and Acetylbrom-aminobenzenes on Amines and Phenylhydrazine: F. D. Chattaway and K. J. P. Orton.

FRIDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 9.—Metals as Fuel: Sir W. Roberts-Austen, F.R.S.

PHYSICAL SOCIETY, at 5.—How Air subjected to X-Rays loses its Discharging Property, and how it Discharges Electricity: Prof. Emilio Villari.—(1) On the Propagation of Cusped Waves and their Relation to the Primary and Secondary Focal Lines; (2) On Cyanine Prisms, and a New Method of Exhibiting Anomalous Dispersion: Prof. R. W. Wood.

INSTITUTION OF CIVIL ENGINEERS at 8.—Automatic Coupling: J. L. Cridlan.

SATURDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (Essex Museum of Natural History Stratford), at 6.30.—Recent Work in Molluscan Morphology: Prof. G. B. Howes, F.R.S.

MONDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 3.—Practical Mechanics: Prof. J. A. Ewing, F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Some Aspects of South American Geography: Colonel G. E. Church.

SOCIETY OF ARTS, at 8.—The Bearings of Geometry on the Chemistry of Fermentation: W. J. Pope.

INSTITUTE OF ACTUARIES, at 5.30.—The Increase of Cancer: R. Teece.

TUESDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 3.—The Cell as the Unit of Life: Dr. A. Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Rotatory Process of Cement Manufacture: W. H. Stanger and Bertram Blount.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Notes from Five Years' Work with X-Rays: W. Webster.

WEDNESDAY, FEBRUARY 27.

SOCIETY OF ARTS, at 8.—The Outlook for the World's Timber Supply: Dr. W. Schlich.

THURSDAY, FEBRUARY 28.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ARTS, at 4.30.—Railways and Famine: Horace Bell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Conclusion of discussion on Mr. Madgen's paper.—Followed, if possible, by Cables: M. O'Gorman.

FRIDAY, MARCH 1.

ROYAL INSTITUTION, at 9.—Enamels: H. H. Cunynghame.

GEOLOGISTS' ASSOCIATION, at 8.—The Post-Pliocene Non-Marine Mollusca of the South of England: A. S. Kennard and B. B. Woodward.—The Pleistocene Fauna of West Wittering, Sussex: J. P. Johnson.

SATURDAY, MARCH 2.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh.

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THURSDAY, FEBRUARY 28, 1901.

THE ORIGIN OF WORLDS.

Kant's Cosmogony as in his Essay on the Retardation of the Rotation of the Earth, and his Natural History and Theory of the Heavens. With introduction, appendices, and a portrait of Thomas Wright of Durham. Edited and translated by W. Hastie, D.D., Professor of Divinity, University of Glasgow. Pp. cix + 205. (Glasgow: James Maclehose and Sons, 1900.)

IN this work Prof. Hastie has not only given us a very readable book, but has written an important chapter in the history of astronomy. His main object is to make us recognise in Kant a profound genius, and to give us reasons for this appreciation. The author was well advised, for Kant, in the domain of natural science, enjoys a somewhat nebulous reputation. Few would care to say with exactness what particular view Kant supported concerning the origin of the cosmos, to what extent he was assisted by earlier writers, or how much of his work has been approved by later physicists. It was inevitable that the work of Laplace, appearing at a later date and supported by a renown won by his successful solution of problems connected with celestial mechanics, should occupy a position of wider acknowledgment and receive the assent of those who, unable to add any support or offer effective criticism to his theory, were content to rely upon his deservedly high reputation. Thus it has come about that more than one writer has owed his knowledge of Kant to very second-hand sources, and while only very imperfectly apprehending the points of difference in the systems suggested by the two philosophers, has allowed the later to eclipse and supplant the work of the earlier writer. Perhaps it is not too much to say that until Prof. Newcomb's "Popular Astronomy" appeared, no intelligent comparison between the theories of Kant and Laplace could be found in any popular work written in English. Prof. Hastie has, however, removed any difficulty that any one might experience in endeavouring to master Kant's views at first hand, and there is no longer any excuse for incomplete knowledge. In excellent English, and we have no doubt with faithful adhesion to the original, he has given us more than all of that portion of Kant's work which the author himself considered to be supported by fair demonstrable inferences. This translation, indeed, oversteps the point at which Kant authorised the publication of his work by J. F. Gensichen in 1791. The remaining portion seems to have been too imaginative and fanciful to receive the support of Kant's maturer judgment, but Prof. Hastie has translated the whole, and the part yet unpublished may see the light if a favourable opportunity offers.

Not only has Prof. Hastie given us Kant's views in practically his own words, but by adding a sketch of the theories of other writers of the period, such as Lambert and Wright, and, later, those of Herschel and Laplace, he has reconstructed the environment in which Kant lived, and permitted us to see in some measure the extent of his acquirements and the gradual increase of later knowledge. To Wright, indeed, to whom Kant admits his obligations, the translator has rendered an act of justice by giving at very considerable length both the account of his suggestions, as they appeared in the *Hamburgische Freyen Urtheile* for 1751, and De Morgan's comments on Wright's hypothesis. Perhaps there was less reason for dealing at equal length with Lambert and the elder Herschel, but enough is given to permit the relations between these old astronomers to be readily apprehended. The result of the examination of Kant's work, and of the comparison with other writers on the same subject, has manifestly given Prof. Hastie very exalted views of Kant's power and insight; and by the use of various expressions he invites us to declare that "a greater than Newton is here."

"Newton was too resolutely opposed to hypotheses not directly founded upon empirical facts, and too anxious to keep within the limits of exact calculation, to give reins to his imagination in the physical sphere. But Kant, gifted with a rare combination of empirical observation and speculative thought, was especially equipped with a genius that could grasp and combine the 'two worlds' in one" (p. lxxxvi).

And again—

"His (Kant) evolutionary theory was thus co-extensive with the Universe, and included all its parts and all its developments. He was thus the precursor in the eighteenth century of Herbert Spencer and Darwin in the nineteenth; but he was greater than both in that he established the general principles of which they have only given particular expressions" (p. lxxxvii).

Laplace also fares badly at Prof. Hastie's discriminating hands—

"Kant, indeed, does not write with the admirable lucidity and ease of Laplace, but he has greater strength, more intensity, richer poetic vision" (p. cvii).

We doubt if this generous view of Kant's powers will meet with a ready assent from many readers. But every one will give him credit for the possession and development of one great thought. He saw and appreciated more clearly than any who had lived before him that the creation of the Universe was the result of a process, and not of an act or succession of acts, implying breaches of continuity. He unfalteringly demanded the banishment of all supernatural interferences from the ordered development of nature, and perceived the possibility of deriving the most complicated forms from the universal laws of motion regulating the simplest elements of matter. To rise above the trammels of dogmatic theology, and to give scientific expression to the evolutional processes of nature, were remarkable feats in his age and in the condition of physical science, and much may be forgiven him if in some of his details he shows a lack of accuracy, or if some of his conceptions are in formal contradiction with the principles of mechanics. And his reputation will still stand high if we freely admit that there are errors, or at least inconsistencies, in his cosmogony. There is a tendency in the very able introduction of Prof. Hastie to explain away these errors, and to contend for a closer agreement between the views of Kant and modern scientific theories than really exists. This treatment seems to us injudicious, and tends to raise a spirit of contradiction which really detracts from the very high estimate any one must form of Kant, simply considered by his work in the physical sciences.

T

Kant's announcement of the appearance of his cosmogony is found in a paper which he wrote, discussing a possible alteration in the time of the earth's axial rotation. We doubt if anything like justice has been done to Kant's memory in connection with this discussion. He there pointed out, in the clearest possible manner, two important facts which in recent times have received very considerable attention, and the early mention of which by Kant discloses a far-reaching apprehension of the operations of celestial mechanism. One is the view revived by Delaunay at the time of the controversy concerning the amount of the secular acceleration of the moon's motion, that the action of the tides must tend to diminish the time of the earth's rotation. The other is, that the explanation of the fact that the moon, in revolving round the earth, turns to it always the same hemisphere, can be traced to tidal influence. But if these two bold speculations have not met with the attention to which they are entitled, Kant himself was not a little to blame for this neglect. For he subsequently adopted the notion that the daily rotation of the earth was accelerated by the falling of heavy particles from the solid crust of the earth towards the centre, supposed to be fluid, and such particles carrying with them a greater velocity of rotation than the lighter particles which might be ascending from the centre. It is, perhaps, of no great consequence to point out here that modern analysis tends to the conclusion that our globe is solid throughout, but it is not a little curious to notice that Kant did not seem to apprehend that the introduction of a second hypothesis does not in any way affect the validity of the former argument. The possibility of the two causes operating together, and the ultimate effect depending upon the amount of their difference, does not seem to have occurred to him. But the paper as it stands in the text betrays a feverish, unphilosophical hurry. The argument is marred by misdescriptions that would have been eliminated by the exercise of more care, and one might well doubt whether Kant fully appreciated the importance of his own suggestions.

But in the presentation of his cosmogony, properly so-called, he lavished all the care and skill of which he was master. Laplace hid his suggestion of the nebular hypothesis away at the end of a volume as though he were ashamed of it, or was afraid that the introduction of more or less hypothetical matter might damage the effect of his rigorous demonstrations. Kant, on the other hand, believing that he was writing a classic for all time—perhaps he was—felt himself entitled to dedicate his work to his sovereign, and was content to base his reputation on the legitimacy of his hypotheses and the use he made of them. But mankind has, perversely enough, connected the nebular hypothesis with the name of Laplace rather than with that of Kant.

To Thomas Wright, of Durham, the author, according to Prof. G. H. Darwin, of a book of preternatural dulness, Kant is indebted for his general view of the construction and arrangement of the Milky Way. Whatever merit or originality the "grindstone theory" possesses, the credit of its discovery seems to be undoubtedly due to this author, and the additions that Kant attached to the description are not particularly happy. For he not only regarded the nebulæ as presenting distant views of remote galaxies and constellative systems in which the construction of our Milky Way was repeated, but he created a central sun about which each star had its appointed orbit, and around which it would run its course during endless ages. We cannot, therefore, follow Prof. Hastie in his assertion that Kant "improved and simplified Wright's theory, giving it a more exact scientific expression" (p. lxviii). Nor are we prepared to admit that "spectroscopic results are so far in entire harmony with Kant's view, and have only extended its range and certainty" (p. c). Spectroscopic observation has not supported the conclusion that nebulæ are due to the combined light of distant suns, so remote that the light from them, condensed into a small space, is visible to us as a tiny luminous cloud. In this place it is sufficient to refer either to the philosophic views held by Schiaparelli, or the more complete examination of these bodies of which an account has been given by Sir Norman Lockyer. Nor is it probable that the stars, collected as they are into irregular clusters or masses with comparatively vacant spaces between them, constitute a stable system. There is no evidence of the existence of a central body of vastly greater mass than the stars surrounding it, which is almost an essential feature to the maintenance of such a system.

But it may be urged that Kant's greatest success is to be found in his construction of the solar system. In the bold conception

"I assume that all the material of which the globes belonging to our solar system—all the planets and comets—consist, at the beginning of all things was decomposed into its primary elements and filled the whole space of the universe in which the bodies formed out of it now revolve" (p. 74),

he anticipated Laplace in the essential portion of the nebular hypothesis, and though his conception is marred by one great dynamical error, yet possibly his origin of the cosmos comes nearest to that at present held by the greatest authorities. If Kant's theory be maintained in detail it would seem to lead, not to a planetary system, such as at present exists, but to a central sun formed by the collection of all the matter in the "meteoritic plenum." But this may be a quite possible condition at one stage of the process, just as Laplace's hot rotating nebula, with which his hypothesis starts, may represent a later stage. For Lord Kelvin is understood to trace the solar system to an originally

"cold nebula consisting of separate atoms or of meteoric stones initially possessed of a resultant moment of momentum equal to that of the solar system. Collision at the centre will reduce them to a vapour, which then expanding far beyond Neptune's orbit will give a nebula such as Laplace postulates."[1]

But Kant's great error consists in the assumption that a motion of rotation could be produced from a state of rest by repulsive forces acting upon the rarer masses of the condensing matter, which would give rise to a whirling motion. This is to ignore the fact that the sum total of rotatory motion in a system can never be increased or diminished by the mutual action of its separate parts.

It is needless to dwell on such points as the suspected increase of eccentricity in planetary orbits with increase of distance from the sun, or the explanation offered for the varying densities of the planets with the variations of

[1] G. F. Becker, "Kant as a Natural Philosopher," *American Journal of Science*, vol. v., February 1898.

the radius vector. An effort to bring into quantitative correlation such constants as density, eccentricity, or inclinations of axis, must end in failure for Kant. He will be judged, not by details, but on the general principle by which he claimed to have arrived at a just comprehension of a complete cosmogony. Similarly, one may pass over his genesis of satellites and the formation of Saturn's ring. Of the former it is sufficient to say that both Kant and Laplace saw in the existence of satellites the repetition on a small scale of the formation of the solar system. We know now the extreme probability that the moon owes its existence to a quite unique arrangement, and it would be hazardous to affirm that any one process has been operative in more than one planet. With regard to the latter, if the existence of a ring about Saturn is suggestive of the manner in which planets came into existence, neither Kant nor Laplace could give sufficient reasons to account for the stable condition of the ring in that system and the instability in others.

The problem of the ordered solar system is one around which much future controversy will arise, and possibly the ambition of neither the astronomer nor the physicist will go further than to suggest how it might have been effected on a plan that does not contradict any known physical laws or inferences. This is very different from saying how it actually "rose out of chaos." Prof. Hastie quotes with approval a remark of Kant, "that it is more difficult to explain the genesis of a caterpillar than the origin of a world." If this be true, it may be due to the fact that we know less about the fabric of the Universe than of the caterpillar, and it is consequently easier to be convicted of error in the smaller than in the greater matter. Kant, together with all makers of cosmogonies, enjoys the advantage that the accuracy of the theories cannot be submitted to any adequate test. W. E. P.

THE HERPETOLOGY OF NORTH AMERICA.

The Crocodilians, Lizards, and Snakes of North America. By E. D. Cope. Reprinted from the Report of the U.S. National Museum for 1898, pp. 153–1270. With woodcuts and 36 plates. (Washington, 1900.)

THE eminent position held by the late Prof. Cope among workers on the taxonomy of vertebrates in the latter half of the past century is chiefly due to the fact that, as has been the case with Prof. Gegenbaur in the field of comparative anatomy, he applied the teachings of the evolutionary theory from the very outset, at a time when other zoologists, imbued with the Cuvierian and Müllerian principles, were still striving at natural arrangements on physiological bases. The ideas set forth in the revolutionary essays on the classification of Batrachians and Lizards, by which he first made his name known, though at first received with little favour by his fellow-workers in Europe, have gradually made their way, and may be said to have well stood the test of time. Although considerably modified in many points both by himself and by others in the intervening thirty-five years, Cope's views hold the field to a greater extent than those of any other taxonomist of the same period. Later in his career, similar attempts at the general classification of Reptiles and Fishes have, in the opinion of the reviewer, been equally successful.

The quick perception of the importance of apparently trivial anatomical details, the veritable instinct with which he realised their phylogenetic bearing and selected them for the purpose of connecting forms widely remote in the systems of his predecessors, and led to conclusions which have, in many instances, ultimately been confirmed by palæontological discoveries, have rendered his name famous in Europe as well as in America. During the later years of his life, however, hasty and careless work, a constant striving at originality, to a certain extent marred the productions of his never-ceasing activity. This may be said of his latest attempts at improving the classification of the Lizards and Snakes, the results of which are incorporated in the thick volume of over 1100 pages now issued by the Smithsonian Institution. It is not stated by whom the work has been seen through the press, nor whether and to what extent the original MS. has been touched up, an omission through which it appears uncertain whether the late author or the editor is responsible for various startling errors which one feels disinclined to ascribe to the former.

The present volume forms part of a series of monographs intended to illustrate the cold-blooded lung-breathers of North America, a work which was devised many years ago by the late Prof. Baird, whose MS. and a number of carefully-drawn figures were placed in the hands of Prof. Cope in 1864. The Batrachians appeared in 1889, the Chelonians were to have been described by Prof. Baur, whose death so nearly followed that of the author of the present treatise, dealing with the remaining orders, viz., *Loricata* (Crocodiles) and *Squamata* (Lizards and Snakes).

As regards the first of these two orders, which includes only two North American living types, *Alligator mississippiensis* and *Crocodilus americanus*, it seems surprising that so advanced a reformer of classification should still have adhered to the inclusion of the *Parasuchia* among the Crocodilians. These Triassic types differ in so many respects from the later *Eusuchia*, and have so much in common with the Rhynchocephalians and the Sauropodous Dinosaurs, that their separation as a distinct order (*Thecodontia*) appears imperative if exact definitions of the allied groups are to be attempted.

Prof. Cope's arrangement by which the *Lacertilia*, or *Sauria* as he prefers to call them, and *Ophidia*, forming the bulk of the fauna, are brigaded under *Squamata* is well in accordance with the present state of knowledge, the supposed characters on which the two groups were formerly allowed ordinal rank being quite insufficient for that purpose. But, in the opinion of the reviewer, a classification in which the *Rhiptoglossa* (Chameleons) are regarded as a mere super-family of Lizards, equivalent with the *Pachyglossa* (*Agamidae*, *Iguanidae*), *Nyctisaura* (*Geckonidae*, *Eublepharidae*), *Uroplatoidea*, *Thecaglossa* (*Varanidae*), *Helodermatoidea*, *Diploglossa* (*Zonuridae*, *Pygopodidae*, *Anguidae*, *Xenosauridae*), *Leptoglossa* (*Teïidae*, *Xantusiidae*, *Lacertidae*, *Gerrhosauridae*, *Scincidae*, *Acontiidae*, *Dibamidae*, *Anelytropidae*), *Annielloidea* and *Annulati* (*Amphisbaenidae*), absolutely fails to express the degree of relationship between them and the members of other families; and if one turns to the synopsis on pp. 200 and 201, in which the distinctive features of the

primary groups, here inadvertently termed "orders" and "suborders" (*cf.* p. 178, where the *Sauria* are described as a suborder), are set forth, one cannot fail to be struck by the want of logic and of perception of proportions which characterises the new arrangement. It may also be pointed out that the group *Annielloidea* has been omitted from the synopsis; this is but one out of many clerical oversights of a similar kind which a rapid inspection of the volume reveals.

A glance at the definitions of the species in the difficult genera, such as *Sceloporus* and *Cnemidophorus*, shows that the subject has not been mastered. An attempt to name an extensive series of *Scelopori* with the aid of the key given would, it can be predicted, result in failure.

In the classification of the snakes, the author agrees with the reviewer in the main divisions. The innovations are mainly due to the consideration of the structure of the intermittent organ or "hemipenes" of the male, by the use of which character many changes have been introduced in the limits of the genera and in their groupings, changes which are not likely to meet with general acceptance. Far too few species have as yet been tested with regard to this character, and Cope himself admits of occasional exceptions, which have turned up in the course of his investigations, such as when one of the paired organs has proved to belong to a division of his system different from that of its fellow on the same specimen. *A priori*, it does not seem that the development of folds and spines on such an organ is at all likely to have so deep a signification as to assist in establishing subfamilies and genera; to adduce a somewhat parallel example, we might as well attempt to employ the differences in the nuptial excrescences of male Batrachians for the definition of genera and even higher groups. And if we are to judge of the value of the character by the changes which its consideration warrants in the groupings of the genera, its introduction in the system does not appear as anything in the way of an improvement.

The investigation of the lung characters, to which the author has devoted so much attention, is a more useful piece of work, so far as taxonomy is concerned, and it may be mentioned that through it the view once propounded by the writer of this notice that the Amphisbænids may be directly derived from degraded types of Teiids, has proved to be untenable.

Allusion has been made above to some extraordinary errors which have crept into this work. Two may be mentioned, *à propos* of snakes, as illustrations:—P. 1127, the *Hydrophiinae* are stated to "leave the water to deposit their eggs"; p. 1129, *Echis carinatus* is described as the "Krait" of India.

The illustrations are numerous and for the most part excellent, and an interesting essay on the geographical distribution of Batrachians and Reptiles concludes this monograph, which, in spite of its imperfections, such as it is a reviewer's duty to point out, will prove of great service to the student of a highly interesting but most difficult group of animals, our knowledge of which has been so greatly advanced by the genius and industry of Prof. Cope. The work is also useful as a catalogue of the specimens preserved in the United States National Museum in Washington. G. A. B.

PRACTICAL PHOTOMETRY.

Photometrical Measurements. By W. M. Stine, Ph.D., Williamson Professor of Engineering, Swarthmore College. Pp. xi+270. Illustrated. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.) Price 6*s*. 6*d*. net.

AS a "manual for the general practice of photometry, with especial reference to the photometry of arc and incandescent lamps," this work will be found useful. Most of the descriptions of photometers are clear and well illustrated, and much practical information about standards of light is collected together. That strange medley of apparatus enshrined in an expensive tabernacle of mahogany and velvet called by gas engineers a "photometer" is not even mentioned, possibly because the book is of American origin. Photometers, and those parts of the art of photometry which are of use to engineers, may be defined without much difficulty, and the apparatus and methods suitable for the research laboratory may be grouped together; when to these is added the theory of the subject, the whole ground of photometry is covered. But the author makes no such distinctions, and the value of his work suffers. While his reference to spectro-photometry is meagre, and the bolometer is dismissed in less than six lines, he drags in double integration to determine the mean spherical intensity of a purely academical case of distribution. On the other hand, he treats possible cases of distribution in a clear and practical way. The description of a Bunsen photometer in the crude form of a screen without mirrors or prisms, and an ancient algebraical theory of the Bunsen screen, containing no reference to the angle of emission or direction of view, marks the author, as do many other passages, as a science teacher. He is in good company; there is hardly a text-book of physics in English in which that useless affair is not represented as a Bunsen photometer. In common with most science teachers, he assumes that the shadows of a Rumford photometer must be widely separated, and he very properly alludes to the lack of sensitiveness which results. When Lord Kelvin said that no one could need a better photometer than a pencil and a white card he knew that the edges of the shadows should meet, and, it may be added, that the shadows should completely cover the card. The little-known, but valuable, Conroy, Ritchie and Thompson photometers, varieties of the Rumford, are described, and the somewhat over-rated Lummer-Brodhun apparatus is criticised. To describe the use of the rotating sector without allusion to Abney, the light of the arc without reference to Fleming, S. P. Thompson or Mrs. Ayrton, and measurement of the mean spherical candle power of arcs without reference to Blondel, can hardly be excused by the attempt to compress the whole book into 261 pages. That the author is a professor of engineering may account for the excellence of the practical parts of the manual; but that, being a professor, some of the theoretical parts are so obscure is strange.

He must needs allude to "the logarithm of the ratio" in defining Fechner's law, because he is a professor; he goes on to give a lucid arithmetical example, because he is an engineering professor, but after a page relapses

hopelessly into totally unnecessary integration in order to get back to the professorial logarithm.

The nomenclature of photometrical quantities is dismissed in a few lines with the very true remark that "the tendency toward particular nomenclature of physical quantities has been carried to a burdensome excess in many cases, until it has assumed the nature of scientific fetichism." "The attempts" of Hospitalier are alluded to, but the author has paid so little attention to the matter that he falls into sad confusion in the use of the expression "illumination." The word is used in half a dozen senses—as a sensation, as a flux, as a quantity of light, and so on. It is true that the "lux" of Preece or Hospitalier are no guide, but the "carcel-metre" or the unscientific "candle-foot," when once understood, leave not the slightest ambiguity about the meaning of "illumination."

The chapter on standards of light is excellent, but the table of comparisons of standards, taken from Laporte, does not include the British candle. Only two items out of a dozen appear to agree with the more complete table of Palaz. The British candle, with all the refinements of the gas referees, is not a unit which does credit to physical science, but it is at least as definitely known, reproducible and measurable as any other standard of light.

The arrangement, illustrations and index are good; the spelling is English. A. P. T.

OUR BOOK SHELF.

The Nature and Work of Plants: an Introduction to the Study of Botany. By D. T. MacDougal, Ph.D., Director of the Laboratories, New York Botanic Garden. Pp. xvii + 218. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1900.)

THIS is a bright and readable little volume, in which plants are treated of mainly from a natural history and physiological point of view. It deserves to be successful, if only as showing that it is possible to gain a fairly considerable, and certainly intelligent, insight into the ways of plants, and that without first mastering the mass of technical detail which too often renders elementary books on botany so repulsive to beginners.

The author commences with a general account of the materials of which plants are composed, and of the structures of which they are built up, the student being led to investigate for himself the different facts and principles enunciated. The phenomena of reproduction, irritability and the like are introduced as objects of observation, and in such a way as to arouse, rather than by satiating to quench, curiosity. The seed and fruit are more fully dealt with, as they afford examples in which adaptations to special purposes can be made out with some degree of clearness, and their individual peculiarities are well explained. If one feels some doubt as to the wisdom of selecting the coconut as an introductory example of a fruit, one cannot complain of the mode in which its structure is treated. The very interesting case of *Xanthium*, in which two fruits are contained in a common sheath, one seed of which germinates in one year whilst its fellow remains dormant till the following season, will probably be new to some readers on this side the Atlantic.

A short chapter on plant societies closes the volume, which may be warmly commended as one likely to excite an interest in many people who fancy that the acquirement of a more or less complicated vocabulary is an essential preliminary to a scientific study of plants. Naturally, the book is not without its faults. Some of these seem to be those of carelessness, of which there is an example on p. 11 in the implication that a dried plant consists of charcoal (!) and ash. But these defects are not numerous, and do not seriously affect the general excellence of the book

Practical Coal Mining. By George L. Kerr. Pp. x + 462. (London: Charles Griffin and Company, Ltd., 1900.)

IN the vigorous outburst of technical literature that the last few years have witnessed, the subject of mining has not been forgotten, and the student of this subject has his choice of a fair number of works of a high degree of merit, amongst which those published by Messrs. Griffin and Co. take foremost rank. It was therefore to be expected that a new book on coal mining, issued by these same publishers, ought to surpass anything previously written on this subject, or at any rate to present features of especial importance. It is to be regretted that these anticipations have been very far from being realised, and, indeed, that it is difficult to discover anything in the work now under review that justifies its publication. It is very largely made up of extracts from the works already referred to, as well as from others, nor are these extracts by any means the worst part of the book. The author's style is far from clear, and many passages might be quoted that would be quite unintelligible to any one who was not acquainted beforehand with the subject-matter; this obscurity of languages often merges into inaccuracy and want of precision—the latter fault being one of the most dangerous that could well be found in a book intended to be placed in the hands of a student. A couple of examples of this fault may be cited: on p. 3 the author writes that "the line at right angles to the direction of 'dip' is called the 'strike,'" a definition that is not true unless qualified by the statement that the line referred to is a line within the bed; it is obvious that there may be an infinite number of lines at right angles to the direction of dip, but only one of these is the strike. Again, on p. 326, we find the following: "When two shafts are sunk and connected by a passage, and the density (weight) of air in the two shafts is equal, no current of air will circulate, no matter what their respective sizes may be." This, again, is only true if it be postulated that both shafts are of precisely the same depth, otherwise an air current may circulate.

The author is weak whenever he touches upon scientific ground; he uses mechanical formulas without apparently appreciating their limitations, as, for instance, when he applies formulas for the bending of columns, ignoring the fact that these are only applicable within the elastic limit. Similarly, his mechanical conceptions of the work done by the winding engine (p. 221) are incorrect. That his chemistry is not much more satisfactory may be judged from the occurrence of such phrases as "glycerine nitrate" for nitro-glycerine, &c.

The best chapter in the book is that on "Modes of Working," the methods of coal-getting in use in Scotland being well described. Indeed, had Mr. Kerr confined himself to a small book describing merely those points in which Scotch practice differs from the English, notably in shaft-sinking, coal-getting and haulage, he would have produced a contribution of distinct value to the literature of coal mining, a phrase that can, unfortunately, not be applied to his present more ambitious attempt. H. LOUIS.

Bookkeeping for Business Men. By J. Thornton and S. W. Thornton. Pp. vi + 185. (London: Macmillan and Co., Ltd., 1900.) Price 3*s.* 6*d.*

BOOKKEEPING is only the application of common-sense principles to the classification and systemisation of accounts. Its purpose is to show how the financial facts of a business may be expressed in the clearest and shortest

way, so that the financial position can be readily understood. A pupil who has been taught arithmetic in a reasonable way can adapt his knowledge to the forms of bookkeeping in a few weeks when placed in an office. For people who have not had the advantage of a rational education, it is necessary to draw up hard and fast rules, which must be obeyed in order to keep accounts intelligibly. The volume under notice does this, by showing as simply as possible how a trader unfamiliar with bookkeeping may construct, keep and balance a set of account books suited to his own business. A set of "Automatic Balancing Charts" is published separately as a supplement to the book, and they are drawn up in such a way that it is almost impossible for a person of average intelligence to make an incorrect entry upon them. Both the book and the charts should prove of service to business men unfamiliar with the intricacies of bookkeeping.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by Sir Batty Tuke, M.D., and D. Noel Paton, M.D. Vol. vii. (Edinburgh: Oliver and Boyd, 1900.)

THIS volume consists of a series of original papers which, since the end of 1897, have emanated from the laboratory of the Royal College of Physicians of Edinburgh. Practically all these papers have been published previously in the medical or scientific journals, and in this form have no doubt been read by those interested in their subject-matter. This is, however, perhaps only partially true of two reports which were presented respectively to the Fishery Board for Scotland and to the Prison Commission for Scotland. The first report consists of sixteen monographs on the life-history and the physiology, under varying conditions, of the salmon; and concludes with a monograph, by Dr. Dunlop, upon the food value of the salmon at different seasons, and obtained from different sources.

Dr. Dunlop is also the author of a report to the Prison Commission for Scotland upon prision dietaries. The report seems to be an exhaustive one, and contains many suggestions with regard to the adaptation of the diets in prisons to the varying conditions and labour employments of the prisoners.

Mother, Baby and Nursery. By Gènevieve Tucker, M.D. Pp. xvi + 193. (London: T. Fisher Unwin, 1900.) Price 1*s.*

THIS is one of the many manuals written for the guidance of young mothers. The writer is an American doctor, but suitable to every mother are the clear and practical directions on the management of herself and her infant. The earlier chapters are concerned with heredity and the conditions favourable for the unborn child. The practical advice is valuable, but it is misleading that the author's opinions on questions of heredity are stated as generally acknowledged facts. The chapters on the care of the infant are suggestive and helpful, and the importance of early training in good habits beginning during the first month of life is insisted upon duly and wisely; but the following advice is extraordinary and *not* to be recommended: "Take a good-sized raisin, cut open, taking out the seeds, put it on the umbilicus." A chapter containing a classification of the diatheses of infants (scrofulous, tuberculous types, &c.) seems out of place in a manual of this description. At the end of the book there is a short and emphatic summary of what is and what is not to be done in the nursery; but among the "nursery don'ts" we notice the omission of a warning against a practice too common, at any rate, in this country, namely, the use of so-called baby-soothers.

Interest is added to the book by the introduction of photographs of young children, but we dislike to see advertisements embodied in the text.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Vortex Rings.

IN the course of some experiments preparatory to a lecture on vortex rings, I have introduced certain modifications which may be of interest to teachers and students of science.

The classic vortex-box is too well known to require much description. Our apparatus, which is rather larger than those in common use, is a pine box measuring about a metre each way, with a circular hole 25 cms. in diameter in one end. Two pieces of heavy rubber tubing are stretched diagonally across the opposite or open end, which is then covered with black enamel cloth tacked on rather loosely. The object of the rubber chords is to give the recoil necessary after the expulsion of a ring to prepare the box for a second discharge. Such a box will project air vortices of great power, the slap of the ring against the brick wall of the lecture hall being distinctly audible, resembling the sound of a flip with a towel. An audience can be given a vivid idea of the quasi-rigidity of a fluid in rotation by projecting these invisible rings in rapid succession into the auditorium, the impact of the ring on the face reminding one of a blow with a compact tuft of cotton.

For rendering the rings visible I have found that by far the best results can be obtained by conducting ammonia and hydrochloric acid gases into the box through rubber tubes leading to two flasks in which NH_4OH and HCl are boiling. Photographs of large rings made in this way are reproduced in Fig. 1, the side view being particularly interesting, showing the comet-like tail formed by the stripping off of the outer portions of the

FIG. 1.

ring by atmospheric friction as it moves forward. It is needless to say that the experiment with the visible rings should be left until the end of the lecture. The power of the air-rings can be shown by directing them against a flat pasteboard box, stood on end at some distance from the vortex apparatus, the box being at once overturned or even driven off on to the floor. A large cluster of burning gas jets can be extinguished by the impact of a ring, a modification of which experiment can be shown on a small scale by shooting a capped shell in a shot-gun at a candle several paces off. If one's aim is good the candle will be extinguished by the invisible vortex.

For showing the elasticity of the rings by bouncing one off the other, I find that the best plan is to drive two in rapid succession from the box, the second being projected with a slightly greater velocity than the first, all experiments that I have made with twin boxes having yielded unsatisfactory results.

Though the large vortices obtained with an apparatus of this description are most suitable for lecture purposes, I find that much more beautiful and symmetrical rings can be made with tobacco smoke blown from a paper or glass tube about 2·5 cms. in diameter. It is necessary to practice a little to learn just the nature and strength of the most suitable puff. Rings blown in this way in still air near a lamp or in full sunlight, when viewed laterally, show the spiral stream lines in a most beautiful manner. I have succeeded in photographing one of these rings in the following way. An instantaneous drop shutter was fitted to the door of a dark room, and an arc-lamp focussed on its aperture by means of a large concave mirror. The shutter was a simple affair, merely an aluminium slide operated with an elastic band, giving an exposure of 1/300 of a second. A photo-

graphic plate was set on edge in the dark room in such a position that it would be illuminated by the divergent beam coming from the image of the arc when the shutter was opened. A ruby lamp was placed in front of the plate, and rings were then blown from a tube in front of the sensitive film. As soon as a good ring, symmetrical in form and not moving too fast, was seen to be in front of the plate, a string leading to the shutter was pulled and the plate illuminated with a dazzling flash. The ring casts a perfectly sharp shadow owing to the small size and distance of the source of light; the resulting picture is reproduced in Fig. 2. The ring is seen to consist of a layer of smoke and a layer of transparent air, wound up in a spiral of a dozen or more complete turns.

The angular velocity of rotation appears to increase as the core of the ring is approached, the inner portions being screened from friction, if we may use the term, by the rotating layers surrounding them. This can be very nicely shown by differenti-

FIG. 2.

ating the core, forming an air ring with a smoke core. If we make a small vortex box with a hole, say 2 cms. in diameter, fill it with smoke and push very gently against the diaphragm, a fat ring emerges which rotates in a very lazy fashion, to all appearances. If, however, we clear the air of smoke, pour in a few drops of ammonia and brush a little strong HCl around the lower part of the aperture, the smoke forms in a thin layer around the under side of the hole. Giving the same gentle push on the diaphragm, we find that the smoke goes to the core, the rest of the ring being invisible, the visible part of the vortex

FIG. 3.

spinning with a surprisingly high velocity. Considerable knack is required to form these thin crescent-like vortices, the best results being usually attained after quite a number of attempts have been made. A drawing of one of these smoke-cores is shown in Fig. 3. The actual size of the vortex being indicated by dotted lines, it is instructive as showing that the air which grazes the edge of the aperture goes to the core of the ring. The experiment does not work very well on a large scale, though I have had some success by volatilising sal ammoniac around the upper edge of the aperture by means of a zig-zag iron wire heated by a current.

By taking proper precautions we can locate the smoke elsewhere, forming a perfect half-ring, as is shown in Fig. 4, illustrating in a striking manner that the existence of the ring depends in no way on the presence of the smoke. The best way to form these half-rings is to breathe smoke very gently into a paper tube, allowing it to flow along the bottom, until the end is reached, when a ring is expelled by a gentle puff. A large test tube with a hole blown in the bottom is perhaps preferable, since the condition of things inside can be watched. It is easy enough to get a ring with most of the smoke in the lower half, but to get a ring, one half of which is wholly invisible, the

FIG. 4.

smoke ending abruptly at a sharply defined edge, as shown in the illustration, requires a good deal of practice. I have tried fully half-a-dozen different schemes for getting these half-rings on a large scale, but no one of them gave results worth mentioning. The hot wire with the sal ammoniac seemed to be the most promising method, but I was unable to get the sharp cut edge which is the most striking feature of the small rings blown from a tube.

In accounting for the formation of vortex rings, the rotary motion is often ascribed to friction between the issuing air-jet and the edge of the aperture. It is, however, friction with the

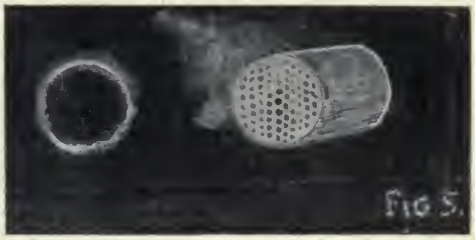

FIG. 5.

exterior air that is for the most part responsible for the vortices. To illustrate this point I have devised a vortex box in which friction with the edge of the aperture is eliminated, or rather compensated, by making it equal over the entire cross-section of the issuing jet.

The bottom of a cylindrical tin box is drilled with some 200 small holes, each about 1·7 mm. in diameter. If the box be filled with smoke and a sharp puff of air delivered at the open end, a beautiful vortex ring will be thrown off from the cullender surface (Fig. 5). We may even cover the end of a paper tub

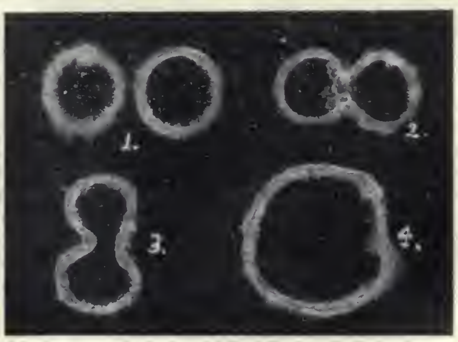

FIG. 6.

with a piece of linen cloth, tightly stretched, and blow smoke rings with it.

In experimenting with a box provided with two circular apertures I have observed the fusion of two rings moving side by side into a single large ring. If the rings have a high velocity of rotation they will bounce apart, but if they are sluggish they

will unite. At the moment of union the form of the vortex is very unstable, being an extreme case of the vibrating elliptical ring. It at once springs from a horizontal dumb-bell into a vertical dumb-bell, so rapidly that the eye can scarcely follow the change, and then slowly oscillates into the circular form as shown in Fig. 6. This same phenomenon can be shown with two paper tubes held in opposite corners of the mouth and nearly parallel to each other. The air in the room must be as still as possible in either case. R. W. WOOD.

University of Wisconsin, Madison.

Dust-tight Cases for Museums.

THE new geological museum now being erected here will have high windows and a long south aspect. The effect of this will be that the sun will fall suddenly on glazed cases and as suddenly pass off them, thus by the expansion and contraction of the air causing dust-carrying currents to force themselves through every chink. From this cause it costs about three times as much to keep cases and specimens clean on the side exposed to the sun as it does in the shaded part of a museum. This may be obviated by elastic diaphragms (which would hardly allow sufficient movement for such large cases as ours) or by small sliding shutters packed with cotton-wool something like Tyndall's respirators.

Can any of your readers refer us to museums in which such a system has been tried, or give us any advice on the subject before our cases have been built? T. MCKENNY HUGHES.

Woodwardian Museum, Cambridge, February 19.

Audibility of the Sound of Firing on February 1.

SIR W. J. HERSCHEL'S letter is very interesting, and I should like to make a few remarks upon it. To begin with, it must, I think, be granted that the discharge of the guns was almost simultaneous. The special correspondent of the *Times* on board the *Majestic* says, "and then simultaneously all the vessels in the long lines joined in, like the tolling of the passing bell." And the special correspondent of the *Times* at Osborne says: "A minute's interval . . . again the quick red flashes down the line, and again the dilatory roar." But why do we find the full minute's interval at Eastbourne, and three reverberations a minute at Oxford? Assuming that there was no firing at Windsor, the reason, I think, must be sought for in the very different character of the roads the sound had to travel over to reach these respective places. In our case the road was all over the sea with the exception of a few miles of low-lying land at Selsey Bill. On the other hand, to reach Oxford the sound would be greatly impeded by the contour of the land, to say nothing of some possible echo from the high ground of the Isle of Wight. Independently of Sir W. J. Herschel's letter, I have grounds for thinking that the sound followed the course of the valleys, and it is possible that the separate reports per minute emerged by as many different channels of passage and of echo. To have received the sound in a straight line, that is to say, to have been high enough to have seen the ships at Spithead, one would have had to have been at an elevation of somewhere about 2800 feet at Eastbourne and 3200 feet at Oxford.

Eastbourne. H. D. G.

Influence of Physical Agents on Bacteria.

IN your report of Dr. Allan Macfadyen's lecture on the influence of physical agents on bacteria (p. 359), I should like to call attention to one point. Dr. Macfadyen suggests that since phosphorescent bacteria regain their power of emitting light after being cooled to the temperature of liquid hydrogen, it may be the case that life is not dependent for its existence on chemical reactions. Because, says he, at the temperature of liquid hydrogen, *e.g.* $-250°$ C., all chemical reactions are well-nigh, if not absolutely, at a standstill, if life were dependent on chemical reactions for its continuance, at that low temperature life would be destroyed. I would submit that this is a case of *non sequitur*. It appears exceedingly probable that the action of excessive cold in *suspending* and stopping vital phenomena, while not *destroying* the capacity of organisms to resume their vital activities, supports the prevalent view that life is dependent on chemical processes. For may it not be that excessive cold, while preventing the vital processes from taking place, by no means alters the chemical constitution of the complicated molecules, the interactions of which normally produce vital phenomena, and leave these molecules, which one may call biogens or anything else, in exactly the same state as they were immediately before the onset of excessive cold, ready as soon as the conditions become suitable once more to resume those vital processes which are known as metabolism.

As an illustration of what I mean I will quote a case of inorganic phosphorescence. It is well known that phosphorus is slowly oxidised in air and emits light at the same time. This reaction takes place when the air is at the pressure of the atmosphere, and the partial pressure of the oxygen is one-fifth of an atmosphere. If, now, the pressure of the air be made equal to five atmospheres, or if the air be replaced by pure oxygen at a pressure of one atmosphere, in both of which cases the pressure of oxygen is five times as great as before, the oxidation ceases and the phosphorescence vanishes. But this is only because the conditions are unsuitable, the constitution of the phosphorus and the oxygen is unaltered, and as soon as the pressure of the oxygen is lowered the phosphorescence begins once more. In both cases, the bacteria and the phosphorus, the action of the physical agent—in the one case cold, in the other pressure—is merely to render the conditions unsuitable for the appearance of the phenomenon, and not to destroy the possibility of its subsequent revival. H. D. D.

Balliol College, Oxford, February 10.

Malaria and Mosquitoes.

I WAS stationed in Karachi, Sind, for more than twenty years. There was undoubtedly a strong belief with the Indians that the disturbance of ground for building led to fever; building operations may be estimated by the fact that I went to a city of 45,000 inhabitants and left 130,000. Not long before I left, the ground of the native town was disturbed by the installation for the first time of a system of underground drainage. I think, but am not sure, this was followed by an outbreak of fever.

Qua mosquitoes, may there not be a distinction between malarious and ordinary fever. F. C. CONSTABLE.

Wick Court, near Bristol, February 24.

Snow Crystals.

AFTER the recent heavy snow in this district, the slight fall yesterday afternoon did not, at first, attract much attention, appearing like sleet to the casual observer. It proved, however, to be of an unusual character, consisting chiefly of beautifully-formed single crystals. It was remarked that "it was snowing stars;" and the ground became covered with myriads of them, varying in size, some being a quarter of an inch in diameter. These "frost flowers" appear to have been common enough in Tyndall's Alpine experiences, but are, I imagine, rarely seen in England upon this scale. The thermometer registered 30° Fahr., and it would be interesting to know if this phenomenon was peculiar to the High Peak district, and what are the conditions conducing to such a display. WM. GEE.

Buxton, February 19.

A "NEW STAR" IN PERSEUS.

WE have received the following:—*Edinburgh Circular*, No. 54. A new star was discovered in Perseus, by Dr. T. D. Anderson of this city, on February 21, 14h. 40m. G.M.T. The star was then of the 2·7 magnitude, and shone with a bluish-white light. Dr. Anderson gave as its approximate place for 1901·0:—

R.A. 3h. 24m. 25s. Decl. + 43° 34'.

At 6h. 58m. G.M.T., on the 22nd, the undersigned estimated the Nova as 0·3 magnitude brighter than α Tauri, and at 8h. 10m. considered it equal to Procyon, which it closely resembled in colour.

On the 23rd, at 8h. 10m. G.M.T., Dr. Halm and Mr. Clark found the new star 0·2 magnitude brighter than Capella.

A direct-vision prism on the 6-inch refractor showed nothing beyond a perfectly continuous spectrum. With the large Cooke spectroscope on the 15-inch equatorial the first impression was the same as with the smaller

apparatus; but on closer examination about half a dozen delicate dark (Fraunhofer) lines were made out by Dr. Halm, extending from a little below D to about F. The spectrum of the Nova, at its present stage, is therefore of a distinct but feebly developed solar type. The existence of these lines I was able to confirm, but the sky became gradually obscured before their positions could be satisfactorily determined.

At about the same hour a photograph of the Nova was secured by Mr. Heath at a time when all the neighbouring stars were obscured by haze. Except a very short interval on the 23rd, the sky here has been completely overcast since the 22nd.

The Nova was independently discovered by Mr. J. E. Gore at Dublin at 11h. 15m. Dublin time on the 22nd, and by Mr. W. B. Dodd and Mr. H. Wake, of Whitehaven, on the 23rd inst. RALPH COPELAND.

Royal Observatory, Edinburgh, February 25.

On the night of the 25th observations were made at the Solar Physics Observatory, South Kensington, the general results of which have been stated by Sir N. Lockyer as follows in a letter to the *Times*:—

(1) The spectrum strongly recalls that of Nova Aurigæ.

(2) There are at least two light sources involved; one with a dark-line spectrum, the other giving chiefly the bright lines of hydrogen, helium, asterium and calcium.

(3) Some of the bright lines are probably reversed.

(4) The broadening of the bright lines is considerably greater than that observed in Nova Aurigæ.

(5) It has been determined by a comparison spectrum of Bellatrix, on the same plate, that the middle of the bright lines occupies nearly the normal position in the spectrum; the greatest breadth of lines observed extends over some 30 tenth-mètres.

(6) The centres of the bright and dark lines are separated by about 15 tenth-mètres, showing a differential velocity of somewhere about 700 miles per second between the colliding light sources.

(7) The star is keeping up its magnitude so far as may be gathered from a very brief observation made between clouds on Friday. To-night (February 25) it has been brighter than Aldebaran, slightly less bright than Capella.

PHOSPHORESCENCE AS A SOURCE OF ILLUMINATION IN PHOTOGRAPHY.

IN certain libraries there exists a fixed rule that no books may be removed. This being so, all extracts and copies of plates and engravings have to be made in the libraries. Reproduction by the methods of ordinary photography is most inconvenient, since the employment of artificial light is strictly prohibited; also the introduction of a camera, and its manipulation in a library, are surrounded by many difficulties. These circumstances led me to devise the following method for obtaining copies of plates, engravings, printing and writing. A piece of cardboard is coated with a phosphorescent substance, and, after sufficient exposure to the light of the sun or of an arc lamp, it is placed at the back of the engraving or writing to be copied; on the face of the engraving or writing a dry photographic plate is placed, and then the book is closed for a certain time, depending on the nature and thickness of the paper used in the book. I find that the period of time lies between eighteen and sixty minutes. The plate is then withdrawn and stored in a dark box for development. The dry plate is easily manipulated under a cloth, which shuts off all light and covers the book during the operation. The results are sufficiently good for most purposes—in the case of some papers the fibrous structure is shown; this very slightly detracts from the clearness of the copies made by this process. Neither the luminous substance nor the dry plate injure the book in any way, so that the method may be employed in the case of valuable prints and engravings (Fig. 1). If films be used instead of plates, a large number of copies of different engravings in the same book may be made at the same time. The time of exposure to the phosphorescent backing is shortened considerably by placing the phosphorescent card on a warm surface, such as that of a metal vessel heated to about 20° C. with hot water;

FIG. 1.

when films are employed, this temperature should not be exceeded. In an experiment made in the laboratory I found that the phosphorescent substance under normal barometric pressure became brightly luminous when subjected to the brush discharge of a Tesla inductor; the discharge from an ordinary induction coil fails to produce the same effects. F. JERVIS-SMITH.

THE ROYAL SOCIETY'S ADDRESS TO THE KING.

ON Saturday last His Majesty the King received deputations with addresses from the Universities of Oxford and Cambridge, General Assembly of the Church of Scotland, the Corporation of the City of Liverpool, and the Royal Society.

The Royal Society was represented by Sir William Huggins, K.C.B. (president), Mr. A. B. Kempe, treasurer (mover), Sir Michael Foster, M.P., secretary (seconder), Dr. T. E. Thorpe, C.B. (foreign secretary), Lord Lister, Lord Kelvin and Sir J. D. Hooker (past presidents), and Mr. W. H. M. Christie, C.B., Astronomer Royal (vice-president). The following was their address:—

TO THE KING'S MOST EXCELLENT MAJESTY.

The Humble Address of the President, Council, and Fellows of the Royal Society for Promoting Natural Knowledge.

Most Gracious Sovereign,—We, your Majesty's most dutiful and loyal subjects the President, Council, and Fellows of the Royal Society of London for Promoting Natural Knowledge, humbly beg leave to offer our deepest and most heartfelt sympathy with your Majesty in the great sorrow which has befallen you in the death of your beloved mother, our late Sovereign Lady the Queen. Your Majesty's loss is our loss, a loss not only to ourselves, not only to all your Majesty's subjects throughout the Empire, but to the whole world. During your beloved mother's wise and beneficent reign under her thoughtful fostering care that natural knowledge which the society was founded to promote has been promoted to an extent and in ways never known before, and we feel sure that not in our time only, but in the years to come, to the story of the advance of science in the past century will be most closely linked the memory of the goodness, the wisdom, the peerless worth of the august and

beloved lady whose death has now plunged us into the deepest grief.

While thus uttering words of sorrow we ask leave, sire, at the same time, to lay at your Majesty's feet our unfeigned and heartfelt congratulation upon your Majesty's accession to the Throne of your ancestors to reign over a people to whom happily your Majesty is no stranger, but who have by many experiences learned to recognise your great worth, and have been led to the sure hope that under your gracious rule the nation will continue to hold the proud position which it has gained under the guidance of your beloved mother.

That your Majesty's reign may be long, happy, and glorious, and that you may ever rule in the hearts as well as over the persons of a loving, dutiful, and grateful people is the earnest wish and ardent prayer of your Majesty's loyal and dutiful subjects, the President, Council, and Fellows of the Royal Society of London.

The King's reply was as follows :—

I am much gratified by the warm expression of your loyalty and affection, of your profound sympathy with our present grief, and of your loving appreciation of the goodness and great qualities of my dearly beloved mother. I thank you for your dutiful good wishes, and I share your hope that my reign also may be blessed by a continuous growth of my people in enlightenment, refinement, and power for good. The intellectual attainments and energies which your society so conspicuously represents are among the most precious possessions of the nation as aids in securing those high ends, and I remember with gratification the close connection of the society with its Royal founder and my other predecessors on this Throne, and the fact that I am a Fellow, as was also my dear father. You may feel assured of my constant interest in and protection of your work, and in token of my good will I shall be pleased to inscribe my name as patron in the charter book.

NOTES.

WE deeply regret to announce that Prof. G. F. Fitzgerald, F.R.S., died on Thursday, February 21, at the age of forty-nine years.

SIR ARCHIBALD GEIKIE retires to-day, February 28, from the office of Director-General of the Geological Survey of the United Kingdom and Director of the Geological Museum, after a service of nearly forty-six years. He has remained at his post after the usual age-limit in order to complete the annual summary of progress of the institution under his charge. It is understood that, being now freed from administrative duties, he intends to devote himself to the completion of several important Memoirs of the Geological Survey. He is succeeded in his appointment by his colleague, Mr. J. J. H. Teall, F.R.S., who is at present president of the Geological Society.

A VERY interesting announcement referring to the Leonid meteors has been received from the president of the Toronto Astronomical Society. He informs us that Mr. R. F. Stupart, vice-president of the Society, director of the Toronto Observatory and superintendent of the Meteorological Service of Canada, has sent him a copy of the following notes made by an observer at York Factory, Hudson's Bay :—"November 15, 1900. Very general display of shooting stars. Some very big ones N.W. to S.E. Sky full in shoals. November 16.—Shooting stars seen until daylight. Scared the people—they thought it was the end of the world." From these records it appears that a shower of Leonid meteors actually did occur last November.

IT is announced that a strong and influential committee has been formed with a view of erecting a triple monument in Heidelberg, by which the names of Bunsen, Kirchhoff and Helmholtz, whose lives and works are inseparably associated with the scientific progress and the rapid social and intellectual development of the alma mater of that city, should be thus lastingly and fittingly commemorated. It is proposed that special appeals for contributions should shortly be issued to some of the learned societies and academies in the German Empire as well as to some personal friends and admirers of the late three famous men of science, whose friendship they are known to have enjoyed and by whose influence they have benefited in their subsequent scientific attainments. It is understood, however, that the general public will not be invited to contribute towards this Bunsen-Kirchhoff-Helmholtz memorial fund. The chairman of the committee is Dr. Adolf Kussmaul, Emeritus Professor of Medicine in the University of Strassburg, to whose suggestion the movement owes its origin.

THE current issue of the *Journal* of the Franklin Institute contains an interesting account of a discussion on the electric distribution of power in workshops, which brings out very clearly the numerous advantages to be gained by the adoption of this method of distributing power. The rapid success which the system has achieved in America points conclusively to its convenience and economy. As one of the speakers pointed out, electric power originally based its claim to attention on the ground that there was much less loss in distribution, and that a saving of 20 to 60 per cent. of the total power used might therefore be effected by substituting electric for shaft driving. This saving, although at first sight it appears great, may, however, be quite small when considered in relation to the total cost of turning out the finished article which the factory produces, amounting, perhaps, to but a small fraction of a per cent. But electric power, it was soon found, effects saving in many other ways, one of the chief of which is that it enables the positions of machinery to be decided with reference to the machine rather than to the shafting. This means that the available floor space can be much more thoroughly utilised. In the case of the Baldwin Locomotive Works, it was stated in the discussion, the adoption of electric driving has saved so much floor space that the works would have to be made about half as big again to give the same output with shaft driving. In addition to these advantages, electric power has proved more convenient, healthier and less dangerous. With all these recommendations it ought not to be long before it entirely displaces the old-fashioned systems.

A BILL intended to organise the National Observatory of the United States has been introduced into the Senate by Mr. Morgan. The object is to convert the U. S. Naval Observatory into a National Observatory, and the following sections from the text of the bill, given in *Science*, describe the proposed organisation :—"That the Director of the National Observatory shall be an eminent astronomer, appointed by the President, by and with the advice and consent of the Senate, at a salary of five thousand dollars per annum, and shall be selected from the astronomers of the National Academy of Sciences unless, in the judgment of the President, an American astronomer of higher scientific and executive qualifications shall be found. That the Secretary of the Navy may detail for duty as astronomers at the National Observatory such professors of mathematics and other officers of the Navy as he shall deem necessary in the interests of the public service ; but on and after the passage of this Act no appointments shall be made of such professors unless required for service at the Naval Academy."

THE departmental committee appointed by the Board of Agriculture, and presided over by the Earl of Onslow, to inquire into the conditions under which agricultural seeds are at present sold, has completed the report upon the subject. The committee conclude that the seed trade in England is, on the whole, well conducted, and has of late years improved with the advance of science. Nevertheless, the majority of the committee recommend that one central station should be provided in the United Kingdom for the purpose of testing the purity and germinating power of seeds sent to it for official examination.

THE Berlin correspondent of the *Times* gives some of the results of the German census of December, 1900, which have just been published. The population of the German Empire has increased from 52,279,901 in 1895 to 56,345,014. Of this population 27,731,067 are males and 28,613,947 females. Over 83 per cent. of the whole population is contained in the four kingdoms; of these Prussia comes first with (in round figures) 34,500,000 inhabitants, and Bavaria second with 6,200,000. The figures for Saxony and Württemberg are 4,200,000 and 2,300,000 respectively. More than 16 per cent. of the population is resident in the thirty-three towns of over 100,000 inhabitants. Of these thirty-three towns the largest is Berlin, with a population of 1,884,151.

A REUTER telegram from Calcutta states that at a meeting of planters and agents interested in the indigo trade, held on February 20, it was decided to appoint a committee to wait on the Lieutenant-Governor in order to request him to grant a subsidy for further researches, as the results reported by the experts, Messrs. Hancock and Rawson, were highly promising. In the course of the meeting Mr. Karpeles said that Dr. Brunck's advice to Indian planters to give up the indigo trade was not likely to be followed. No reduction in planting was contemplated, and an increased output was expected from the manuring and blower processes.

AT the Wilts County Council's meeting on Friday last, reference was made to the fall of stones at Stonehenge, and a discussion ensued as to the taking of steps for the preservation of the remains. Prof. Story Maskelyne suggested the appointment of a small committee, not necessarily composed entirely of members of the council, but Lord Edmund Fitzmaurice, M.P. (the chairman of the council), explained that the matter was already being dealt with by the Charities and Records Committee, to whom the question of ancient monuments had been referred. It was also stated that the committee was in communication with the landowner and with the Society of Antiquaries, and hoped to report definitely at the next meeting.

WE have to regret the death, on February 15, at twenty-six years of age, of Mr. Fred. Pullar, son of Mr. L. Pullar of Bridge of Allan. In conjunction with Sir John Murray he had recently published an admirable survey of the depths of many Scottish freshwater lochs, illustrated with beautifully engraved charts. The manner of his death was heroic. While skating on Airthrey Loch, near Bridge of Allan, a young lady fell through the ice, and he at once skated to her assistance and plunged in with his skates on. He kept her afloat for ten minutes, but in spite of determined efforts to save them, both perished. Eye-witnesses testify that he might have saved himself but for his devotion to duty. He was an only son, and the warmest sympathy is felt and expressed for his family.

THE Reale Istituto Lombardo has made the following awards of prizes:—Under the Brambilla foundation for improvements in industries or manufactures in Lombardy, a gold medal and 1000 lire to Gadda and Co., of Milan, for electrical machinery; a gold medal and 500 lire to Reiser, Cattoretti, Gola, Norsa and Co., for their manufacture of embroidery with new shuttle machinery; and the same to Carlo Fino for the preparation of cattle food in which blood and molasses are used; and a premium of 300 lire to Virginio Rimoldi for machinery for sewing gloves. Under the Fossati foundation a prize of 2000 lire has been awarded to Prof. A. Stefani for his papers on the regeneration of the peripheric nervous fibres. A number of other prizes remain unawarded. The prizes now offered include a prize of the Institution for the best essay on the differential equations of applied electricity to be sent in by April 1, 1901; a similar prize for 1902 for a toponomastic exploration of a district of Lombardy; two triennial medals for agricultural and industrial improvements in Lombardy; a Cagnola prize and gold medal for the best report dealing with hailstorms on the two sides of the Alpine chain, due April 1901; and a similar prize and medal for 1902, for an essay on the effects of gaseous emanations from manufactories on cultivated plants; another Cagnola prize for a discovery dealing with the cure of pellagra, the nature of miasms and contagion, the direction of balloons, or the prevention of forgery; a Brambilla prize for industrial improvements in Lombardy; Fossati prizes for 1901 and 1902 for essays on the anatomy of the encephalus of the higher animals; and for 1903, on the so-called nuclei of origin and termination of cranial nerves; a Kramer prize awarded to Italian engineers; a Secco-Comneno prize on the Italian phosphatic deposits; a Zanetti prize, open to Italian pharmaceutical chemists; and Pizzamiglio and Ciani prizes for educational and literary writings.

A CIRCULAR letter has been sent out seeking an expression of opinion from experts as to the advisability of founding a journal for the statistical study of biological problems. The letter is signed by Profs. Karl Pearson and Weldon, pioneers in this country in the line of work it is desired to encourage. *Biometrika* is the proposed title of the journal; thirty shillings the estimated cost of the first volume, to consist of four parts; and the proffered programme is an embodiment of memoirs on variation, inheritance and selection based on statistical examination, the development of statistical theory as applied to biological problems, and abstracts of memoirs on these subjects appearing elsewhere in each of the four leading European tongues. The proposal to found this journal is a natural sequel to the appearance during the last few years of the *Archiv f. Entwicklungs Mechanik* and, later, of the *American Journal of Physiology*, so largely devoted to the work of experiment on the living organism. The founders claim for statistical inquiry into biological phenomena a now established position, and give it as their opinion that "many persons are deterred from the collection of such data by the difficulty of finding such a means of publishing their results as this journal would afford." Statistical work in biology, to be of service, must be far-reaching and extensive, and it cannot be well dissociated from morphological inquiry of the better kind. A mere shot here and there at a miscellaneous collection of objects will not suffice now that the experimental stage has been passed, but upon prolonged work of an order involving laborious investigation with a fixed purpose, often with extended experiment, to be made, when possible, over a large area, can reliance alone be placed. Progress must necessarily be slow, and the accumulation of results worth publishing can only be expected after protracted research; and in these circumstances we are doubtful if the desire to burden the already over-crowded literature of biology with a new serial is not somewhat premature. It may be borne in mind that existing periodicals and the organs of societies are available for purposes of publication; and we could well desire for some of these that much of the so-called "systematic" work and quibbling over priority in nomenclature, fast becoming intolerable, might be replaced in work of the statistical and experimental order.

MR. W. A. HICKMAN, New Brunswick Government Commissioner, delivered a lecture on "New Brunswick" at the Imperial Institute on Monday. Like the rest of the maritime provinces of Canada, New Brunswick is situated much nearer Great Britain than any other of the important food-producing areas of the Empire. St. John, the capital, situated at the head of the Bay of Fundy, is the chief winter port of Canada, and the first lumber-shipping port in the world. The province contains 10,000,000 acres covered with heavy forests valuable

for lumber or wood pulp. The manufacture of this pulp from spruce is an industry yet in its infancy, only a few mills being in operation. The demand for the product for paper-making is practically unlimited, and the supply in New Brunswick very great, while the transport facilities of the province for shipment either to British or Eastern American ports are excellent. In 1891 there were no Government-supervised butter and cheese factories, now there are about 100; in 1895 there were no modern roller wheat mills, in 1900 about 80,000 barrels of flour were manufactured. The dykelands round the Bay of Fundy are the most fertile agricultural lands in the temperate zone, and perfectly self-sustaining; as also is the majority of the land situated along the shores of the rivers and lakes.

THE difficulties involved in the manipulation of a long celluloid film have prevented the extensive use of kinematographic apparatus by amateur photographers. To avoid this objection, Mr. Leo Kamm has invented a camera—the Kammatograph—in which a circular glass plate takes the place of the celluloid film. The plate can be made to rotate rapidly by means of a multiplying gear, and at the same time it travels laterally. A small lens forms an image upon the plate, and when the plate is put in motion these images are multiplied into a series of pictures arranged in a spiral. The character of the pictures and their distribution will be understood from the accompanying reproduction of a small part of a series produced in this way. The plate

is, of course, developed precisely in the same way as an ordinary negative, and a positive is then taken from it. To display the series of pictures it is only necessary to place the positive in the camera and to arrange the camera so that the beam from a lantern close to it can pass through the lens. The plate is then rotated as before, and the succession of the pictures projected upon the screen reproduces the original movements. About six hundred pictures can be photographed during the motion of a single plate, at a rate of about twelve or fourteen a second. The camera is very compact, and both as regards price and adaptability is within the reach of any photographer who wishes to secure pictures of rapidly changing scenes and moving objects. The small size of the pictures will not permit of projection upon a large screen, but the views can be shown large enough for ordinary purposes.

FROM the point of view of public health, it is undesirable to cut up open spaces used for recreation near large cities. The Commons and Footpaths Preservation Society directs attention to the fact that there are several private bills, now before Parliament, which propose to take power to interfere with commons, village greens and open spaces. The City and North-East Suburban Electric Railway will seriously affect Hackney Marshes and Leyton Marshes, and, in a lesser degree, Victoria Park. The line is to be for the most part in tunnel, but where it crosses Hackney Marshes and Leyton Marshes, two exceptionally valuable open spaces, it will emerge from the tunnels and run on an embankment varying from 5 feet to 20 feet in height. Two short branch lines will also be erected on the surface of the Marshes, and altogether about twenty-five acres of common land will be abstracted. The North-East London Railway also seek powers to run a line on an embankment, varying from 14 to 31 feet in height, over Walthamstow and Leyton Marshes. The construction of more than two miles of high embankments on a much-used and highly valuable stretch of common land would practically destroy its utility as an open space and injure its amenity. The Society has therefore resolved to oppose the bills.

WE learn from the *Scientific American* that the Niagara Falls Power Company has about completed its second power transmission line between Niagara Falls and Buffalo. The new line possesses special interest because of the fact that the cables are made of aluminium. The three-phase current is transmitted by three cables, each composed of thirty-seven strands. The old line consists of six copper cables, each of which has nineteen strands. One advantage gained in the use of aluminium is that the cables being so much lighter, the span between poles, which in the old line is about 75 feet, averages 112½ feet in the new line. On the completion of the aluminium line, the voltage of the current that is transmitted will be raised from 11,000 to 22,000 volts.

WE have received from Mr. R. F. Stupart, director, a copy of the Report of the Meteorological Service of Canada for the year 1897, a large quarto volume of 292 pages. Observations were made at 314 stations; at the chief stations, where all the ordinary observations are taken day and night at equal intervals of time not exceeding four hours, at the telegraphic reporting stations, where the observations are taken three times daily, and at some few of the special stations, the observers are paid for the time which they devote to the duties required of them, but at the bulk of the stations the work is purely voluntary, the Meteorological Department at Toronto simply supplying the necessary instruments. A liberal exchange of telegraphic reports takes place between the United States and Canada, from which data a very comprehensive daily weather chart is constructed and on the basis of these charts forecasts and storm-warning notices are issued. The storm warnings are very successful, about 86 per cent. being fully verified, while the direction from which the wind would blow was fully verified, to the extent of about 94 per cent. The daily forecasts obtain an average success of 81 per cent. They are disseminated to the agricultural community by discs on the baggage vans of outgoing morning trains. The tables of observations and results are very carefully prepared, and the whole report furnishes an important contribution to climatological knowledge.

THE Society for the Protection of Birds has issued a small pamphlet, by Surgeon-General Bidie, urging the need of effective protection for wild birds in India.

TWO numbers (18 and 19) of the *Circular* of the Royal Botanic Gardens, Ceylon, have reached us; the one giving a list of the kinds of ornamental and timber trees best suited for planting in the island, and the other describing certain caterpillars which infest the tea-plant.

MUCH interest attaches to Mr. J. P. Smith's account, in the *American Naturalist*, of the coiled larval shell found attached to the lower extremity of many specimens of Baculites from the Cretaceous beds of Dakota. This straight-shelled Cretaceous

cephalopod is accordingly considered to be descended from a coiled Clymenia-like ancestor.

WE have received the *South-Eastern Naturalist* for 1900. In addition to several papers, it contains an account of the congress of the South-Eastern Union of Scientific Societies, held at Brighton in June under the presidency of Prof. Howes. Bird protection was one of the subjects discussed, in connection with which the president expressed his opinion that the present unsatisfactory state of affairs is largely due to the apathy of local authorities in putting enactments in force.

THE systematic position of the sand-grouse forms the subject of a paper, by Dr. R. W. Shufeldt, in the January number of the *American Naturalist*. It is concluded that these birds form a subordinal group intermediate between the pigeons and the game-birds. In the same serial Mr. G. H. Parker discusses certain tortoises with abnormally formed horny shields, in which correlated abnormalities likewise occur in the underlying bony plates. And he is led from this association to conclude that in the primitive chelonians each plate was covered by its own proper shield, as in the case of the glyptodons of South America.

To the February number of the *Zoologist* Mr. G. Renshaw contributes an account of all the known specimens, whether alive or dead, by which the quagga has been or is represented in menageries or museums. About ten living examples of this extinct equine appear to have been exhibited from time to time in menageries. Three skins, a skeleton, and two skulls represent the animal in the United Kingdom, in addition to which two other skeletons have been stated to be those of quaggas. Continental museums are more fortunate, possessing among them, in addition to several skeletons and skulls, no less than eleven mounted skins, one of which is that of a fœtus. In the South African Museum this once abundant species is represented only by a foal. A skeleton at Philadelphia, said to be that of a quagga, completes the list of known remains. The author states his belief that the skin and skeleton in the British Museum belong to an individual which died in the Zoological Gardens previous to 1838, in reality they were not acquired till 1864.

IN the *Journal de Physique* for January, M. E. Mathias applies Weierstrass's signs to determine the mutual induction of two parallel circular currents. The advantage of this method is that it enables the potential energy to be expressed as a function of the radii and distance apart of the circuits in a rapidly converging series.

MR. GILBERT NEWTON LEWIS suggests a new conception of thermal pressure and a theory of solutions in the *Proceedings* of the American Academy (xxxvi. 9). The theory, according to which the thermal pressure of any phase is equal to the pressure which the substance would exert if under the same conditions as a perfect gas, suggested itself in the consideration of certain remarkable general laws which treat of heterogeneous equilibrium in which the several phases are subject to different pressures. The same assumption is alone sufficient, according to the author, to explain all the laws of dilute solutions. The relations of Mr. Lewis's theory to the theory of van der Waals are also discussed.

THE January number of *La Géographie* contains a paper by Dr. A. G. Nathorst, of Stockholm, on the distribution of the wolf and the musk-ox in high northern latitudes, and especially in Eastern Greenland. Count Henri de la Vaulx contributes a paper on his journeys in Patagonia.

THE new number of the *Mitteilungen aus den deutschen Schutzgebieten* is devoted to an account of the work of the German members of the British and German Boundary Commission between Lakes Nyasa and Tanganyika. There are special reports, on the astronomical and geodetic work, by Dr. E. Kohlschütter, and on the country and people, by Captain Herrmann. Four sheets of an excellent map on a scale of 1 : 100,000, by the members named and Lieut. Glauning, accompany the reports.

THE Eighth Annual Report (for 1899) of Dr. S. Calvin, the State Geologist, forms vol. x. of the Iowa Geological Survey. It contains a useful index geological map of the State; a report on the mineral production, which includes coal, clay, stone, gypsum, and lead, zinc and iron ores; and sundry geological reports. Mr. Stuart Weller deals with the succession of fossil faunas in the Kinderhook Beds at Burlington. These faunas exhibit a gradual transition from those with Devonian to those with Carboniferous characters. The Devonian element is for the most part exhibited by the pelecypods, while the brachiopods ars usually Carboniferous in aspect, and there is an overlapping and intermingling of these forms. The geological reports deal very fully with different counties in Iowa.

IN the *Proceedings* of the Liverpool Geological Society (vol. viii. part iv., 1900) we find an interesting address by Prof. W. A. Herdman on "The Geological Succession of Morphological Ideals." Referring to the many distinct groups of animal life found in the Lower Cambrian rocks, and which are usually taken to indicate that "we are already pretty far up in the history of evolution, and very far in time from the primitive fauna," he expresses the opinion "that the first differentiation of the great groups of invertebrates may have taken place very rapidly in pre-Cambrian times at the surface of the sea amongst soft-bodied pelagic animals." He then discusses the chief faunas of the Palæozoic rocks, pointing out the successive organic types which dominate as "representatives of the ideals which Nature seemed striving to attain in the successive geological periods."

THE observatory on Mount Etna, being situated at a height of 2950 metres, at the foot of the central crater and only 300 metres below the summit, it has been assumed that the ground on which it is built must be almost continually in a state of tremor. To show how unfounded the supposition is, Messrs. A. Riccò and L. Franco have made a comparative study of the tromometric records from the observatory there and from that at Catania, the instrument employed being the normal tromometer $1\frac{1}{2}$ metres long, and the readings being taken six times a day for nearly eight years. In 46 per cent. of the observations on Etna, and in 62 per cent. of those at Catania, the tromometer was found to be in motion. The higher figure at Catania is partly due to the influence of external agents; for, when the sea is rough, the tromometer there is never still, while on the mountain it is unaffected. Also, taking only those observations made when the wind was strong, or very strong, the tromometer on Etna was in motion in 59 per cent. of all such cases, and that at Catania in 94 per cent. On the other hand, when there was little or no wind and the sea was nearly, or quite, smooth, the corresponding figures are 38 for Etna and 69 for Catania.

THE fifth part of "Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere, collected during the years 1895–1897," by Dr. Arthur Willey, has been published by the Cambridge University Press. The work will be brought to a conclusion by the publication of one other part in the course of the present year, and when it appears the six parts will be reviewed together.

THREE new volumes in Ostwald's series of "Klassiker der exakten Wissenschaften," published by Mr. Engelmann, Leipzig, have been received. No. 114 contains letters and other communications written by Volta in 1792–1795 upon the subject

of animal electricity, and No. 118 contains Volta's accounts of investigations made by him in the period 1796–1800. No. 115 is devoted to de Saussure's research in hygrometry (1783). The three volumes are edited by Dr. A. J. von Oettingen, and are in German, like the other volumes in the series.

An interesting synthesis of fumaric acid is given in the current number of the *Berichte* by O. Doebner. Under the action of pyridine, condensation between glyoxylic and malonic acids is readily effected. The condensation may be imagined to take place with the intermediate formation of maleic acid, but attempts to isolate this were unsuccessful.

In his account last year of the properties of the remarkable hexafluoride of sulphur, M. Moissan mentioned that other bodies were formed at the same time containing sulphur and fluorine, and in the current number of the *Comptes rendus* he gives, in conjunction with M. Lebeau, a further contribution to this subject. The compound described is sulphuryl fluoride, SO_2F_2, and it is obtained by the regulated action of fluorine upon sulphur dioxide. The conditions of the reaction had to be carefully studied, as the reaction of these two gases is so violent that explosions frequently occur. The new gas is necessarily accompanied by others, owing to the operations being carried out in glass vessels, and the separation of these is effected by liquefying the whole at $-80°$ C. and fractionating *in vacuo*. Sulphuryl fluoride is a colourless, odourless gas, solidifying in boiling oxygen, melting at $-120°$ C., and boiling at $-52°$ C. Although in some respects it resembles its halogen homologues, in its stability and inertness in other reactions it recalls the properties of the hexafluoride. Thus it is without action upon water even in a sealed tube at 150° C. M. Moissan remarks that these experiments show that although fluorine is undoubtedly at the head of the halogen group, it is a little removed from the others, having special and characteristic properties which show affinities rather to oxygen than to chlorine.

The additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*), a Green Monkey (*Cercopithecus callitrichus*), an Anubis Baboon (*Cynocephalus anubis*), an African Civet Cat (*Viverra civetta*), a Denham's Bustard (*Eupodotis denhami*), a Royal Python (*Python regius*) from Falaba, Sierra Leone, presented by Mr. C. E. Birch; two White-collared Mangabeys (*Cercocebus collaris*), a Bay Duiker (*Cephalophus dorsalis*) from West Africa, presented by Mr. E. R. Cookson; a Herring Gull (*Larus argentatus*), European, presented by Mr. C. A. Hamond; a Jay (*Garrulus glandarius*), a Jackdaw (*Corvus monedula*), European, presented by Miss N. Eskell; a Merlin (*Falco oesalon*), European, presented by Mr. Gregory Haines; a Goshawk (*Astur palumbarius*), European, presented by Major-General A. A. Kinloch, C.B.; a Barn Owl (*Strix flammea*), European, presented by Mr. A. Masters; two Dwarf Chameleons (*Chamoeleon pumilus*) from South Africa, an Axis Deer (*Cervus axis*) from India, deposited; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, a Great Ant-eater (*Myrmecophaga jubata*) from South America, two Horned Tragopans (*Ceriornis satyra*) from the South-east Himalayas, four Californian Quails (*Callipepla californica*) from California, four Virginian Colins (*Ortyx virginianus*) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in March.

March 2. 10h. 46m. to 12h. 3m. Moon occults κ Cancri, (mag. 5·0).
6. Outer minor axis of Saturn's ring = 15″·24.
7. 13h. 3m. Minimum of Algol (β Persei).
9. Mars in conjunction with α Leonis (Regulus), Mars 3° 49′ North.
10. 9h. 52m. Minimum of Algol (β Persei).
11. Saturn in conjunction with π Sagittarii (mag. 3·0). Saturn 1° South.
13. 6h. 41m. Minimum of Algol (β Persei).
14. 11h. Jupiter in conjunction with the moon. Jupiter 3° 25′ South.
14. 21. Saturn in conjunction with the moon. Saturn 3° 26′ South.
15. Venus. Illuminated portion of disc = 0·980.
15. Mars. Illuminated portion of disc = 0·979.
24. 7h. 37m. to 8h. 40m. Moon occults ω^1 Tauri (mag. 5·8).
25. 6h. 32m. to 7h. 42m. Moon occults l Taur (mag. 5·5).
26. 9h. 15m. to 10h. 6m. Moon occults 68 Orionis. (mag. 5·6).
28. 6h. 16m. to 6h. 40m. Moon occults 1 Cancri (mag. 5·9).
29. 5h. 30m. to 6h. 33m. Moon occults A^2 Cancri (mag. 5·8).

Variability of Eros.—The recent announcement by Dr. Oppolzer concerning the variation in the brightness of the minor planet Eros is confirmed by the accounts of two French observers, who communicate their results in the current issue of *Comptes rendus* (vol. cxxxii. pp. 396–398).

The first paper, by M. F. Rossard, describes a series of determinations made at the observatory of Toulouse with a Brunner equatorial of 0·23 metre aperture. Estimates with comparison stars were taken on the nights of February 14, 15, 16 at short intervals. Evidence of rapid variation was detected, the difference exceeding a magnitude, the extreme range being from 9·3 to 11·0. The times of the various phases observed were as follows:—

		h. m.				h. m.	
1901 Feb.	14	9 43	min.	1901 Feb.	16	7 34	max.
	14	10 48	max.		16	8 56	min.
	15	8 10	max.		16	10 3	max.
	15	9 32	min.		16	11 30	min.
	15	10 44	max.				

The comparison of these minima and maxima indicates that the variation in brightness shows a little less than ten periods in a day, *i.e.* the duration of the period is about 2h. 22m.; also that the period of increase from minimum to maximum is about 15 minutes shorter than the interval from maximum to the following minimum.

The second note is by M. Ch. André. He says the total variation takes place in about 6 hours, and in character is similar to the variable star U Pegasi, but with the stationary period a little longer, so that the planet Eros is to be regarded as a photometric variable, and may consist of a double system formed of two asteroids, whose diameters are slightly less than 3 : 2, and whose orbital plane passes through the earth. As the distance of Eros from the earth is about two-thirds that of the sun, the inclination of the line of sight on the plane of the orbit will change rapidly and continuously. The study of these variations will be important in giving a series of light curves, in which the only variation is that of the inclination of the line of sight on the plane of the orbit of the satellite.

New Variable Star, 1. 1901 (Cygni).—Mr. Stanley Williams announces the variability of the star situated in the position

$$\left.\begin{array}{l}\text{RA.} = \overset{\text{h.}}{19}\ \overset{\text{m.}}{28}\ \overset{\text{s.}}{1\cdot5} \\ \text{Decl.} = +28°\ 0'\cdot5\end{array}\right\}(1855).$$

The estimated photographic magnitude varied as follows:—

		Mag.
1900 Oct. 27	...	10·7
Nov. 18	...	9·9
Dec. 15	...	10·5

A chart of the region surrounding the star is given, and reference made to a previously published photograph of the region by Dr. Max Wolf (*Knowledge*, 1892, p. 130), on which the star is not shown. (*Astronomische Nachrichten*, Bd. 154, No. 3687).

RECENT WORK OF THE INDIAN MARINE SURVEY.[1]

THE importance of the work intrusted to the Indian Marine Survey, alike from the point of view of the hydrographer, of the geologist, and of the zoologist, is so well known to all men of science that it would be mere waste of time to attempt to emphasise it on the present occasion. All the Reports that have from time to time been published by this Survey bear witness to the zeal and energy with which the work is carried on—frequently under circumstances of great difficulty—and to the capacity and accomplishments of the officers to whom it is entrusted. But it will be no reflection on previous documents of the same nature if we call attention to the special interest attaching to the one now before us, on account of the varied nature of the subjects on which it touches, the philosophical manner in which these are treated, and the problems presented by many of them.

The first section of the Report is by Commander T. H. Heming, R.N., who has entire charge of the Survey; and geologists will read with great interest his account of the rapid silting-up of the Gulf of Martaban that is now in progress. It appears that an enormous quantity of sediment is being carried into the Gulf by the Salween River; a sample of water taken at spring tide during the dry season yielding no less than 1/300th of dry mud by weight. The deposit has mainly taken place outside the 10-fathom line, and so heavy is it that in spots where there were formerly from 40 to 50 fathoms, the depth is now reduced to from 15 to 20; the area affected being approximately 2000 square miles. "Putting the amount of water discharged by the river flowing into the Gulf at a low estimate," says the Report, "and supposing it capable of supporting on the average one-quarter of the proportion of sediment held in solution [? suspension] by the specimen examined, there would be more than enough solid matter carried into the Gulf in forty years to cause the silting-up which has actually taken place."

Another point of interest in this section is the longitude of the Andamans, which, as deduced by running a meridian distance to Sugar-loaf Island, was found to differ by 1′ 70″ from that given by the Great Trigonometrical Survey. In consequence of this discrepancy it is now proposed to run a meridian distance between Port Blair and Diamond Island both ways, in order to obtain the best possible results with the means at disposal.

Passing on to the section of the Report written by the Surgeon-Naturalist, Captain A. R. S. Anderson, we may call attention to the remark as to the rapid change in the coloration and appearance of the animals of Ford Bay, Great Cocos Island, when the coral bottom of the open channel is left for the sandy bottom of the bay. While quarantined off Colombo a lucky haul brought up no less than forty-one examples of the rare crustacean *Lupocyclus orientalis*, of which only three specimens were previously known to science. In another haul, which brought up a miscellaneous collection of dead corals, sharks' teeth, fish-bones and bones of turtles, the interesting fact was discovered that while some of these were in practically the same condition as at the time of their deposition, others had been highly impregnated with mineral matter. No embedding in sediment had, however, preceded the fossilisation (if the term is permissible in this connection), which had evidently taken place as the bones lay loose on the sea-bottom.

In a haul taken some distance east of the Maldives, Captain Anderson was fortunate enough to procure over 200 specimens of an echinoderm nearly related to the West Indian *Palaeopneustes hystrix*, but apparently specifically distinct. When placed in spirit these urchins turned it a magnificent rich purple, although their own colour was a dull madder-brown. Many other rare and interesting invertebrates were obtained at other dredging stations, but we must omit mention of any of these to refer to a totally different subject.

Between Colombo and Rangoon an excellent opportunity was afforded of carefully observing the flight of the common flying-fish (*Exocoetus evolans*). "When they first rise from the water," writes the narrator, "they do so with a very rapid fluttering of their wings lasting for two to three seconds; they then soar along till their speed is so reduced that they descend and touch the water, into which they either fall with a splash or dip the elongated tip of the caudal fin, and, I think, the ventral fins on which they seem to poise themselves, again rapidly vibrate their wings, and get up sufficient speed to renew their flight; this process I have seen them repeat as often as seven times in the course of one long flight. Very occasionally, however, I have observed these fish fluttering their wings without touching the water with their caudal and ventral fins."

After mentioning that in order to observe these motions calm weather and a binocular are necessary, Captain Anderson proceeds to say that he fails to understand how Moseley, as narrated in his "Naturalist on the *Challenger*," as well as several other observers, have denied the fluttering of the wings in flying-fish. Apparently he is unaware that it has been stated in the "Royal Natural History" by the editor, as the result of personal observation, that these fish do possess the power in question, as indeed had been attested in *Land and Water* by a much earlier observer. Captain Anderson's observations also corroborate the statement made by the writer last referred to, that flying-fish are capable of altering the direction of their flight: an attribute that was denied to them by Dr. Möbius in his well-known account.

In a later paragraph Captain Anderson draws attention to the circumstance that in flying-fish the lower surface of the body is flattened in order to enable them the more easily to rise from and hover over the water, and that in the allied genus, Hemirhamphus,[1] the members of which rush at full speed along the top of the water with only the hinder portion of the body immersed, a similar flattening is observable.

While lying in Burmese waters off Moulmein, the surveying vessel encountered a large quantity of drift-wood brought down by the Moulmein river. Some of this became entangled in the paddle-wheels, and on three mornings snakes were found on the floats. A female leopard, probably carried down by the strong tide, took refuge one morning on a cargo boat moored somewhat higher up, and eventually swam ashore, where she was shot. These instances are of much interest in connection with the dispersal of species.

Much of the latter portion of this section of the Report is occupied by an account of the author's experiences in the Andaman Islands, where he has much to say concerning both the natives and the fauna. In one passage he mentions that, while walking through the forest, a native announced the presence of a large mass of wild honey in the immediate neighbourhood, which he detected by its smell, although this was quite imperceptible to the European members of the party.

In conclusion, Captain Anderson refers to the remarkable circumstance that in the neighbourhood of the Andamans there occur masses of sandstone at a depth of between 39 and 226 fathoms which are quite bare of coral, although there is an abundant growth of the same in the immediate neighbourhood. It is inferred that the bare area, and probably also the larger portion of the bank, has never been within the zone of massive reef-building corals. "Had it ever been so, it is most improbable that there should be bare rock exposed at 39 fathoms. For that the bank is eminently suitable for the growth of coral, both the dredgings and the soundings, by bringing up live coral, showed; at no part of the bank was there any turbidity of the water sufficient to check coral-growth. . . . Were the theory correct that, given a bank rising within a comparatively short distance of the surface, deposit will accumulate on that bank and so form a basis for a coral island, there is no reason why, in the case of this bank, bare rock without any such deposit on it should be found."

Many other equally interesting and suggestive extracts might be culled from this valuable report did limitations of space permit.

R. L.

[1] Administration Report of the Marine Survey of India for the Official Year 1898–99. Pp. 17. (Bombay: Government Central Press, 1900.)

[1] A mis-spelling of this and several other names is noticeable in the Report, but, as the writer of this notice is well aware, much allowance must be made for an author whose copy is set up by native Indian printers.

THE TEACHING OF PHYSIOLOGY.

IT is scarcely too much to say that the only real scientific knowledge is that obtained through personal experience. Lectures and text-books have their places in a scheme of instruction in science, but they only convey information at second-hand, whereas original experimental work creates and fosters the inquiring spirit characteristic of a progressive mind. What students need to be taught is that they must be not so much receptive as constructive; and the way to give force to this view is to insist upon their taking an active share in investigation at

every stage of their careers. It is in the highest degree satisfactory to know that this principle is being acted upon in the courses of scientific instruction followed in many of our schools and colleges—more particularly in the Schools of Science and Higher Elementary Schools of the Board of Education. But a large class of students of a higher grade are introduced to scientific subjects on the old-fashioned plan, the reason in most cases being that they have no time to pursue a course of work constructed on rational lines. Metaphorically, they endeavour to enter the field of science by a short cut instead of following the route of patient and persistent observation, and in the end they find themselves without the certificate of admittance into the Delectable City. Medical students are the greatest sinners in this respect, but the fault lies not so much with them as with their masters and examiners. So many subjects have to be taken that it seems almost hopeless to look for greater opportunity for investigation or for the development of a spirit of research in students whose knowledge of practical chemistry is obtained by a few hours' test-tubing. In the teaching of physiology, also, there is a great gap between rational methods and existing practice, and Dr. W. T. Porter, associate professor of physiology in the Harvard Medical School, directs attention to it in an article which we reprint, slightly abridged, from the special educational number of the *Philadelphia Medical Journal*. Dr. Porter shows, in addition, how large classes of students may be carried along the well-known roads that lead to scientific power, and gives the results of one year's experience with a method of instruction different from that usually employed. His paper thus contains a statement of a course which has been proved to be practicable, and has been accepted by the Faculty of the Harvard Medical School. The methods described need not, however, be limited to medical education, as they are based upon principles which, *mutatis mutandis*, can be applied to instruction in any science. The paper is thus worthy of consideration by every one interested in the extension of natural knowledge.

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To the physician the study of physiology is of use largely because it creates a habit of thought essential to the highest professional success. Physiology is a *rational* science. Its problems require the scientific method. They demand the precise statement of the question in hand, a severely critical examination of the results of experiments, and the arrangement of the accepted experiments in the order that shall lead logically, step by step, to a correct solution. Medicine is itself an experimental pursuit. Its higher walks are open only to those skilled in research. The scientific method cannot be acquired by the study of anatomy and pathology in the purely descriptive form in which they ordinarily are presented to the medical student; in this form they are stuff for visual and aural memory—not for the exercise of reason. Nor can the experimental state of mind be readily acquired by the study of clinical medicine. Reliance must be placed on a well-developed, highly rational science, cultivated to train rather than inform the mind, pursued, not for its stores of information, but for the highest product of human faculty—the system of inquiry that leads to light through darkness. Too often in our medical schools information is mistaken for knowledge. Only knowledge is power. The getting of mere information wastes the student's time. The vast accumulations of centuries of medical study confuse the undisciplined mind and crush the spirit. The burden of fact which any man can bear is relatively small, and each year grows relatively smaller. To find new truths and to look undismayed upon the old is the perfect fruit of education. This physiology can give, and on this power to train should rest the high position of physiology in schools of medicine.

The physiological lectures in medical schools are commonly given by one man and cover the entire field of physiology. This field is much too large to permit of even superficial personal acquaintance by one man. Necessarily, therefore, the instructor must take the chief part of his lecture from text-books. To this he adds citations of a few experiments or observations taken from the original sources. He has not and cannot have real knowledge as to the present state of special opinion on the majority of the chapters in his subject, because none but a specialist can cope with the constantly rising flood of meritorious research in any one chapter—to keep pace with the whole of a science which stretches ample arms over the larger part of human and comparative biology is impossible. Physiology could not be taught by the lectures now so largely given, even were lecturers gifted with superhuman knowledge. Physiology deals with phenomena, not with words. Many of these phenomena, for example the heart-sounds, cannot be described; others can be pictured dimly, but only to those who know related phenomena from having actually seen or otherwise sensed them; in no case can lectures properly instruct unless the fundamental facts or closely related facts have first been learned by actual observation in the laboratory. The student should come to the lecture already possessed by his own efforts of the phenomena to be discussed. Chapters, such as metabolism, in which the fundamental experiments are unusually difficult or protracted, should be preceded by less difficult though related chapters. If the obstacles to practical work in any field are insurmountable, the protocols of classical experiments in this field, together with a suitable connecting text, should be studied before the lecture. At present the lecturer too often merely offers a list of facts which mean little or nothing because they cannot be associated in the student's mind with phenomena already observed. The lecturer attempts to remind the student of that which the student never knew. The secondary schools have prepared the student to see nothing strange in this. Most men enter the physiological course persuaded that natural science can be acquired chiefly from books, and leave convinced that a deal of talk and a pennyworth of nature will give real knowledge of the action of living tissues.

A natural science cannot be well taught except by those who have themselves made experimental investigations in the special field which they would teach. No one in these days can work profitably in many fields, and only necessity should make one man attempt to teach them all. A man trained, for example, in the physiology of digestion is likely to have but a relatively feeble grasp on the physiology of the circulation, and nervous system, or the special senses. It follows that most of the instruction in the one-man system does not adequately represent the present state of knowledge. It is behind the times in all except the special field cultivated by the instructor himself. So far as possible, the didactic instruction in each field should be given by the member of the physiological staff actively at work therein, but this wise principle of the division of labour is not usually regarded.

Passing now to the demonstrations, we find that in the larger schools they are made before an audience of at least two hundred. Thus the greater number cannot see the demonstration clearly. If the class be divided into small sections, the brief glimpse allowed each man does not suffice for a full grasp of the details. Very commonly the demonstrations requiring much time are given in a course separate from the lectures. In short, most of the demonstrations as now given are an aid to the memory rather than a means of training in science. The position awarded them by the usual lecturer and by almost every student is one of the evidences of the fundamental pedagogical error which renders most medical teaching of anatomy and physiology so largely futile, namely, the deplorable notion that demonstrations are merely illustrative, and the book and the lecture the main force. Never was the pedagogical cart more squarely before the horse. Contact with nature is the essential of all training in biology.

The laboratory work in large schools is usually done in relatively small sections, and is not coordinated with the regular lecture course. The student feels that the experiments are purely secondary. The experiments are imperfectly arranged into groups. They merely illustrate the text-book. In no case do they present a full picture of any field. The time allowed is so short that criticism of results and insistence upon the proper standard of excellence is not attempted.

The instruction is the same to every student without regard to what his life is to be. Much time is given to matters which have a very remote connection with the future of most students, and which are not better material for training the mind than matter bearing directly on the student's future work.

It is important to inquire how this extraordinary system was developed. The reply is that the present method is a survival of mediæval methods; the student of tradition finds a rich field in the history of medical teaching. The teaching of physiology has broken away from anatomy; men now living have taught both subjects in the same course of lectures. Descriptive anatomy became the most conspicuous discipline in medicine at a time when the best mental training could be had only from books, from lectures, from abstractions. It was the flowering time of metaphysics, of authority, of the deductive method. The true principle of approaching nature discovered by the

Greeks survived only in a few men of genius, a spark that in our own time has been fanned into flame. Joined to the powerful example of the most liberal education of that period was the difficulty of obtaining material for dissection. Stark necessity united with specious theory to fasten upon this most concrete of sciences the methods of the schoolmen, and to this day the bulk of the instruction in anatomy remains didactic, and consists of books, diagrams, and more or less misleading models. Dissections are made to illustrate the book. The printed description is learned by rote, and the dissection practised too often simply as a manual exercise. The anatomy of the medical college is largely a memory drill—such as belongs pedagogically in the secondary schools. These seventeenth-century notions have been passed from anatomy to physiology. That which began as a makeshift has become a dogma.

Practical work in physiology has also been kept back by the erroneous ideas that the cost of apparatus and other materials is prohibitory, that medical students cannot master the details of exact experimentation, that delicate apparatus cannot be trusted in their hands, and that instruction to the extent required cannot be given to large classes because the course will become too complicated to be carried out.

Perhaps the chief obstacle which has kept physiology in an ancient and now almost abandoned path, is the public belief that because anatomy and physiology were once taught chiefly from books, they should still be so taught; that the functions of living organs can be learned from books with the occasional exhibition of dead organs; that the natural sciences should continue to be studied in secondary schools without laboratory work; in brief, that nature can be studied apart from nature. The public has a just contempt for men who profess to have learned disease without practical observation of the sick—experience is conceded to be necessary here—but the public is ready to applaud, and even to compel by law the study of the same organs in their normal state by reading or hearing a description at second hand of what some third person saw. The real drags upon progress are the failure of the secondary schools to teach science by scientific methods, and the fatal conservatism that binds teachers of medicine to a past that we should do well to forget. These venerable delusions no longer impede experts in pedagogy, but unfortunately medical teachers for the most part are more zealous than learned in pedagogy. They fail to see that medical training should be "for power," and only secondarily for information.

If it be replied to these strictures that a system which produces so many able physicians cannot be much in need of improvement, I answer that the men of talent veil the defects of the mass. They owe much to themselves; genius will thrive on the intellectual diet that stunts the merely industrious man. The average student does not build upon a sound foundation. He knows little anatomy, less physiology, and still less chemistry, and even his training in practical medicine has to be supplemented where possible by postgraduate work in a hospital. On the whole, it may be said that his industry has been largely misdirected.

The picture I have drawn of the instruction in physiology in the average medical school will be accepted by teachers of that science. The sense that the usual methods of instruction neither develop nor much inform the mind is general. Careful inquiry should therefore be made to determine how far the defects can be remedied with the means at our disposal. The problem is: How far can the correct theory be realised in practice? To what extent can all students of physiology be taught in the manner in which men are trained to be professional physiologists? Evidently physiologists are likely to study their own subject in the most profitable and labour-saving way.

The expansion of physiology has broken it into specialities. Even professional physiologists can no longer have personal acquaintance with the whole subject, or even a relatively large part of it. To a considerable degree the physiologist himself must acquire his information from reading the work of others. It would therefore be idle to expect the student to get a personal experimental knowledge of the whole subject. His limited time must be used chiefly for training, and not chiefly for the acquisition of facts, as at present, and this training must follow the lines laid down by physiologists for their own development.

Deal so far as possible with the phenomena themselves, and not with the descriptions of them. Where the fundamental experiments cannot all be performed, fill the gap with the original protocols from the classical sources. Associate facts which the student can observe for himself with those which he cannot observe. Use as the basis of professional instruction, where practicable, the facts and methods to be used by the student in earning his living. Teach the elements by practical work. Let the student state his observations and results in a laboratory note-book, which, together with the graphic records of his experiments, shall form one of the requirements for the degree. Control his progress and remove his difficulties by a daily written examination and a daily conference, in which the instructor shall discuss the observations made by the student and supplement them from his own reading. Stimulate the student by personal intercourse in the laboratory, by glimpses of the researches in progress, and by constant reference to the original sources. Diminish the distance between professor and pupil; both are students, and both should be fed on the same intellectual diet. There is but one way to get and keep an education. Demand of every student a written discussion of some very limited thesis, giving the results of the original investigators, together with any observations the student has made for himself. Give the more capable students opportunity for original experimental work. Towards the end of the instruction, when the student is ripe for such work, offer a liberal number of courses of didactic lectures with demonstrations. Let each course consist of from one to four lectures not more than forty-five minutes in length, presenting all that is known of the chosen subject. These lectures should show the student the historical development of scientific problems, the nature of scientific evidence, and the canons of criticism that help to sift the wheat from the chaff of controversy. From the beginning to the end of the instruction hold fast to concentration, sequence and election. Such are the lines along which sound theory would direct the teaching of physiology in medical schools.

Concentration, sequence and election are the safeguards of economical labour.

Whether the student's time is to be given wholly or only in part to the subject taught is the first problem to be solved in planning the actual instruction. Men in training for professional physiology commonly concentrate their energies for a sufficient period on this one subject; and this is regarded as the most economical way of mastering any science, for the ground gained by one day's work is still fresh in the mind when the next day's work begins, and continuity of thought is not disturbed. The plea that the instruction in one subject should be broken by the study of other subjects in order that the instruction in each may have "time to sink in" need not be entertained; experience shows that much of it sinks in so far that it cannot be recovered without the loss of valuable energy. A more serious objection is that the method of continuous application is highly fruitful in men of exceptional powers, who are keen in spite of protracted effort, but is wasteful for the average brain, which is fatigued and unreceptive after some hours of unremitting labour. The truth of this must be allowed; but the objection does not apply to wide-ranging sciences such as anatomy and physiology, which are not narrow, hedged-in areas, but which consist rather of broad and diversified domains composed of many contiguous fields, the varied nature of which is a perpetual refreshment.

A correct sequence of study is also highly important. Very often in medical schools the lectures in physiology are given before the student has any acquaintance with the anatomy of the structures considered, and still more are heard before the student has any true anatomical knowledge—that based on actual contact with tissues and not upon a glimpse of a distant prosection or a hasty glance at a diagram. Similar instances are not uncommon in later parts of the curriculum. The natural sequence demands that the study of structure should precede the study of function, and the study of the normal precede that of the abnormal. Thus the natural order of medical study is descriptive anatomy, physiology, pathology and medicine. There is a considerable advantage in treating organs individually, studying their structure, physiology, pathology, diseases and treatment in continuity, but practical difficulties in arranging such a course make this inadvisable.

Election is correct in theory and unavoidable in practice. Generations have passed since it was possible to teach every clever student all things. Yet in many schools the effort is still made. The herd of students is driven hastily past the monuments of genius and learning in the hope that they who run may read. Students are exhorted to be great, while littleness

is thrust upon them. The obstetrician and the ophthalmologist still receive the same instruction. It is obvious, however, that this indiscriminate gorge will be soon an unpleasant memory. The wonderful growth of medicine is breaking bonds already centuries old. All minds in one mould is ceasing to be the ruling axiom in medical teaching, not because it is a terrible delusion which by retarding discovery has cost the lives of countless thousands, but because it is no longer practical. Success demands some acquaintance with all subjects and an intimate knowledge of one. Day by day the walls rise higher between one speciality and another. The parting of the ways begins at the threshold. In anatomy, physiology and pathology the student should spend his time on those portions which are directly associated with his future work as practitioner or investigator.

This early election will be strenuously resisted by partisans of the tradition. They will contend that the present instruction embracing the entire field is known to give a very inadequate acquaintance with the subjects taught; therefore, instruction covering only a part of the ground will give still less. The argument is beside the mark. The present method of instruction would be inadequate in any event. The medical degree is granted for superficial information in twenty-five or thirty subjects. The sign of the scholar and man of science, namely, thorough knowledge of some one field, is wanting. Yet this training of the man of science is more and more necessary for success. Moreover, a thorough training in at least one subject increases the power of acquiring the fundamental data of related subjects while it protects the mind against superficiality. A further necessity for election is seen in the fact that the great medical schools are university departments. They are attended by an increasing number of men who will never practise medicine but will become investigators in some branch of biological science.

Following the idea of concentration, sequence and election, I have proposed that the student's undivided attention be given to one principal subject at a time. The principal subjects in medicine are anatomy, physiology, pathology and clinical medicine including surgery. The four years' course in medicine is divided into eight terms or semesters, which usually comprise sixteen weeks of instruction. The first of the eight terms may be given to the primary course in anatomy, including histology; the second to the primary course in physiology, including physiological chemistry; the third to the primary course in pathology, including bacteriology; the fourth to pharmacology, clinical chemistry and physical diagnosis; and the four remaining terms to clinical medicine and surgery. The primary courses just mentioned provide the instruction in anatomy, physiology and pathology which every student is advised to take. Advanced instruction in these subjects may be offered in subsequent elective courses.

To meet the needs of the several classes of students found in universities the department of physiology must provide: (1) The primary course already mentioned, suitable for every student of biological science, including medicine; (2) An advanced course, intermediate between the primary course and research; this advanced course will be taken by candidates for the degree of Doctor of Philosophy who have selected physiology either as their principal subject or as one of the two or three subordinate subjects required of such candidates; (3) Opportunities for physiological research.

The primary course in physiology is held from 9 a.m. to 1 p.m. daily during the second term of four months in the first year of the medical curriculum. The afternoons of these four months are devoted to physiological chemistry. The primary instruction in physiology is divided into three parts. Part i., of five weeks' duration, provides thorough experimental work in some limited field. In this, the student should acquire the point of view, the general physiological method, training in technique, and a complete knowledge of one or more tissues to serve as an introduction to the physiology of the remaining tissues. There can be little doubt that the physiology of muscle and nerve should be chosen for this purpose. It is the most fully developed chapter in physiology, and is well adapted to train the mind in habits of exact experimentation and close reasoning. Moreover, the physiology of muscle and nerve is in large measure the physiology of all living tissues, so that a man learned in this one field is in effect already acquainted with the general principles of physiology. Part ii., of about seven weeks' duration, comprises carefully arranged fundamental experiments, giving in turn the elements of each field in physiology except that of nerve and muscle, which has just been studied. In part iii., covering the remainder of the term of sixteen weeks, the instruction is divided into special courses on the physiology of the eye, ear, larynx, digestion, the spinal cord, the innervation of the heart, &c. Each course is long enough to include all the practicable experiments that should find a place in a systematic, thorough study of the subject. The number of such experiments, and hence the length of the special courses, is naturally different in the various instances; thus the experimental physiology of the eye occupies more time than the physiology of the larynx. The student may elect the subjects that most interest him, but must choose a sufficient number to occupy him during the entire four weeks of instruction. In planning these courses the aid of distinguished specialists is sought.

Each student is required to present one written discussion of some small and sufficently isolated thesis, giving the work of the original investigators. The way of dealing with the sources at first hand is thus learned. Many of these essays are read and discussed before the class. The discussions begin with the sixth week of the course and are held daily during nine weeks. None is held during the last two weeks. The literature of each subject is divided into two portions and each is assigned to one man. The fifty-four subjects, therefore, are presented in one hundred and eight essays. The men chosen for this purpose are the best in the class; their choice is determined at first by the results of their examinations in anatomy, and, so soon as practicable, by the results of their work in physiology. In addition to the two men who read theses, one or more of the investigations on each subject are studied by four men, who are thus specially qualified for the discussion. The four are selected in turn from the whole class. To illustrate, let us take as an example "The Transmission of the Cardiac Excitation Wave." One student defends the theory that the cardiac excitation wave is transmitted through muscular tissue; a second defends transmission through nerve tissue. Each presents a carefully written account of the evidence pro and con. The four men, each of whom has read at least one of the investigations on this subject, lead the discussion, which is held by the entire class and the departmental staff. The subjects chosen for discussion are, as a rule, such as cannot be fully studied in the laboratory. Thus the discussions complement the remaining instruction. The subjects to be discussed are bulletined before the appointed day so that the class may come to the discussion somewhat prepared.

In the last two weeks of the course, students who have performed their experimental work especially well may elect instruction in physiological research. The subject chosen must necessarily be very narrow, and, where possible, should be one the literature of which has been already examined in the preparation of the student's thesis. Experience has shown that after fourteen weeks of strenuous labour in experimental physiology, the student of average ability learns to work rapidly and carefully, so that much can be accomplished in two weeks of experimentation in one small subject. Even a very brief experience of investigation is of the greatest value and interest. Examples of subjects suitable for training in investigation are: "The Compensatory Pause;" "The Tetanus Curve;" "The Action of Calcium and Sodium Ions on Rhythmic Contractility."

Beginning with the second week of the course, a daily written examination, twenty minutes in length, is held. One or, at most, two questions are asked. They concern the student's own experiments. The purpose of the examination is to cultivate precision in statement. The emphasis which the question gives imparts a correct perspective. Further, the examination reveals men whose indolence or incapacity marks them for special care. The following questions are some of those asked in such examinations: "Give experimental evidence to show where stimulation begins on the closure of the galvanic current. Explain the difference between the stimulating electrodes and the physiological anode and kathode in the stimulation of human nerves. Give the experimental basis for an explanation of the auriculo-ventricular interval."

The didactic instruction consists of a ten-minute talk in the laboratory, commenting on the examination of the previous day and explaining any special difficulties in the experiments, and of a daily lecture. In every instance this lecture is intended to discuss experiments. Wherever possible the experiments are to be performed by the students themselves before coming to the lecture. Experiments which the students cannot do for themselves

are studied by them from the original protocols, furnished with a suitable explanatory text. Thus the fundamental elementary information is gained from the original sources before the lectures. The students are questioned concerning these fundamental experiments. The questions are arranged in the sequence required for a systematic presentation of the subject. Wherever necessary, the lecturer adds from his own stores to the information already possessed by the student. The class is encouraged to question the lecturer concerning matters not quite clear. At the close of the exercise the lecturer sums up briefly. The end in view is the development of the mind rather than the imparting of information. For example, the fact that the pressure of the saliva in the ducts of the submaxillary gland during secretion is higher than that of the blood in the carotid artery is not presented as a fact to be memorised, but is discussed with reference to its bearing on secretion by filtration; the student has learned the fact itself from the original source before coming to the lecture. Some of the lectures on special subjects, such as the eye, are given by distinguished specialists in practical medicine. Each instructor gives as an elective one or more lectures describing, with demonstrations, his own investigations; the investigator discussing his own experiments is a powerful intellectual stimulus; too little account has been taken of this educational force.

The student should be provided with what may be called a laboratory text-book. This text-book consists of a series of experiments and observations, taken from the original sources, and arranged in the sequence suited to develop the subject. Very often the historical sequence serves this purpose best. The description of the experiment follows the original so far as practicable. The experiments are provided with a suitable commentary text. The student is made to feel at every step that physiology is an experimental science, that the only material proper for discussion consists of observations and experiments free from error, and that safety demands constant reference to the original source. The laboratory text-book is supplemented by the student's laboratory note-book, in which the student preserves the graphic records of his experiments and the notes of his observations.

Little need be said concerning the instruction intermediate between the primary course and research. In the intermediate course the experiments chosen for the individual student vary with his goal, and are arranged in the order that seems best adapted to train the mind for research in the direction desired.

The methods of primary and advanced instruction here presented are obviously the methods of the investigator. They can be carried out effectively only by those whose chief purpose is the advancement of human welfare by discovery. In many schools, instructors are still selected mainly because they can talk agreeably of the work of others; in some, the instructor must have made one experimental study in the subject which he teaches; in a very few of the large schools, the higher positions are occasionally bestowed on men to whom research is more than a memory, but these positions almost invariably are burdened with a mass of petty administrative detail. The university devotes these men to researches which the university prevents them from making. Thereby its best minds are set to its lowest work. A change is necessary here. No man who has not made at least one experimental investigation should be appointed assistant in a department of physiology, no man who has not shown marked capacity for original work should be made instructor, and the professor's chair should be filled only by those in whom the ardour of discovery is not likely to be cooled by the advancing years. At least half the day should be set aside for research, and the hours thus reserved for the highest studies should be guarded against every encroachment. The best elementary instruction can be given only in the atmosphere of research. Discovery fires the imagination of youth, consoles the aged, and lifts the mind from mediocrity to greatness.

W. T. PORTER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech (composed by Mr. A. C. Clark of Queen's College) delivered by Prof. Love in presenting Principal Lodge for the degree of D.Sc. *honoris causa* on February 12:—

Adest Oliverus Josephus Lodge, Naturæ rerum indagator acerrimus. Qui, ut vitam eius brevissime percurram, iam quinquaginta abhinc annos natus in Collegio Universitatis Londinensis primo institutus, in Universitate Londinensi gradum Doctoris Scientiæ adeptus est: mox in Collegio Universitatis de Liverpool Professor Physicæ creatus summa laude viginti annos floruit: anno denique proximo Universitatis novæ de Birmingham primus Præses factus est. Magna iamdudum fama inclaruit hic vir, quod in rebus physicis experimentorum longum ordinem peritissime commentus est et felicissime confecit: quo in genere sæpe numero ei contigit ut re acu tacta difficillimam aliquam quæstionem, in qua hæserant doctissimi Physicæ auctores, felicissime explicaret. Primo quidem quæ et qualis sit vis illa Naturæ moderatrix, quam ἐνέργειαν vocant, quibus mutationibus utatur, quærebat, neque laborum laude debita diu caruit a Regali Societate iam tredecim abhinc annos Sodalis electus. Iam tum vestigia Fitzgeraldiana secutus radiorum electricorum naturæ studere inceperat. Docuerat enim Maxwell, huius rei peritissimus, vim electricam oscillationibus quibusdam per inane spatium transferri posse, quo duce usi apud Germanos Hertzius, apud nostros Lodge, harum oscillationum signa et indicia certa deprehendere conabantur. Hertzium quidem ad metam primum pervenisse non nego, ad quam tamen Lodge eandem viam ingressus certo cursu ferebatur: illud vero affirmaverim veritate ab Hertzio patefacta hunc meliorem viam quærentibus monstravisse et novæ doctrinæ prædicatorem insignissimum exstitisse. Neque civium utilitatibus non inserviebant eius labores, cum in nuntiis arte telegraphica sine filo metallico mittendis, tum in fulminibus avertendis et in postes aeneos, tectorum nostrorum tutamina, sine fraude derivandis. His denique diebus magnam rem felicissime aggressus est cum quæreret de terræ cursu per medium illud ætherium, quo lux et vis omnis electrica et magnetica pervehitur, et doceret hoc medium, quod vocant, penitus stagnare et materiæ crassioris motibus omnino carere. Multum denique profecit in natura radiorum illorum explicanda quos Lenardus, Röntgen, Zeeman, viri acutissimi, primi detexerunt. Insignem eius operam in his variis generibus agnovit Universitas Sancti Andreaa, quæ gradu Legum Doctoris, et Regalis Societas quæ numismate aureo Rumfordiano eum iure ornavit.

Neque id silendum arbitror quod huic viro intima Naturæ penetralia reserare nequaquam satis erat, sed et in tironibus instituendis et in rebus gubernandis pari industria et felicitate eminuit: quo in genere haud parvam partem laudis suæ debet Universitas de Liverpool, de qua optime meritus est. Huius viri ingenio multiplici latior profecto campus iam datur, cum Universitatis novæ de Birmingham Præfectus sit.

The Junior Scientific Club held their 221st meeting on Friday, February 15. Mr. W. B. Croft, M.D., of Pembroke, read a paper on "The management of light waves," which was followed by a paper by Mr. A. C. Inman, of Wadham, entitled "René Descartés, and his physiology."

Mr. R. E. Baynes, Lee's Reader in Physics, has been appointed a delegate of the University Museum, in place of Sir John Conroy, F.R.S., deceased.

The Provost of Oriel (D. B. Munro) and the President of Trinity (H. F. Pelham) have been appointed representatives at the ninth Jubilee of the University of Glasgow.

CAMBRIDGE.—Mr. W. D. Niven, F R.S., has been appointed an elector to the Cavendish professorship of experimental physics.

THE *American Naturalist* for January gives a list of gifts and bequests made to various educational institutes in the United States for eleven months of the year 1900, ending November 30; they amount to over sixteen million dollars. The largest amount is a gift, not to exceed three million dollars, from Mr. Andrew Carnegie, for the enlargement of the Carnegie Institute, Pittsburg, Pennsylvania. The number of gifts or bequests recorded is about eighty.

THE report of the Technical Education Committee of the Derbyshire County Council shows that continued progress is being made in the provision of adequate laboratory and workshop accommodation in important centres of the county. In the department of agriculture, the headquarters of the agricultural teaching have been transferred from Nottingham to the farm centre at Kingston, where additional buildings have been constructed to enable practical science work to be carried on.

THE Senate of the Royal University of Ireland has passed the following resolution:—"That in the opinion of the Senate the

relations of the University with its own colleges and students are unsatisfactory, and it is most desirable that a Royal Commission should be issued to inquire into the working of this University as an examining and teaching body in relation to the educational needs of the country at large, and to report as to the means by which University education in Ireland might receive a greater extension and be more efficiently conducted than it is at present."

AN influential committee, headed by the Duke of Devonshire, the Duke of Argyll, the Earl of Derby and Earl Spencer, have issued an appeal with the object of raising 150,000*l.* in celebration of the jubilee of Owens College, Manchester. Fifty thousand pounds are needed to discharge debts that have been contracted and 100,000*l.* for additional endowment. Among the objects the promoters have in view are the extinction of the debt of 22,000*l.* on the buildings of the medical school; special endowments for existing chairs, including chemistry, education, anatomy and philosophy; the establishment of an institution for bacteriological investigation and for the study of hygiene, and of research Fellowships; and the creation of a pension fund for members of the teaching staff.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxiii. No. 1, January.—The new volume opens with a memoir by S. Kantor, entitled "Die Typen der linearen Complexe rationaler curven im R_r."—E. J. Wilczynski writes on transformation of systems of linear differential equations. It has been shown by Staeckel (*Crelle*, band 111) that the most general transformation, which converts a general homogeneous linear differential equation of order $m > 1$ into another of the same form and order, is

$$\mathrm{T}: x=f(\xi), y=\phi(\xi)\eta,$$

where $f(\xi)$ and $\phi(\xi)$ are arbitrary functions of ξ. If $m=1$ the most general transformation is

$$x=f(\xi), y=\phi(\xi)\eta^{\lambda} \text{ (λ a constant).}$$

The present paper considers a *system* of linear differential equations, and finds the most general transformation which converts such a system into a system of the same order. The transformation thus formed contains T as a special case. Staeckel's method is adopted in essence. The author is working at a theory of invariants of such systems, based on this general transformation.—Distribution of the ternary linear homogeneous substitutions in a Galois field into complete sets of conjugate substitutions, by L. E. Dickson, and the following paper, "Distribution of the quaternary linear homogeneous substitutions in a Galois field into complete sets of conjugate substitutions," by T. M. Putnam, are in continuation of a memoir by the former writer in vol. xxii. (pp. 121–137).—On the determination and solution of the metacyclic quintic equations with rational coefficients, by J. C. Glashan, is a tardy fulfilment of a promise made in vol. vi. p. 114.—E. O. Lovett contributes a construction of the geometry of Euclidean n-dimensional space by the theory of continuous groups.—A table of class numbers for cubic fields, by Legh W. Reid, is calculated with a view to furnishing for the general algebraic number fields an amount of number material sufficiently great to be of use in the further study of these fields, and in particular in that of the cubic fields. It gives for each of 161 cubic number fields the class number, h, the discriminant Δ, a basis, and the factorisation of certain rational primes into their prime ideal factors. The method is founded upon a theorem of Minkowski's. In every ideal class there is an ideal, j, whose norm, $n(\mathrm{j})$, satisfies the condition

$$n(\mathrm{j}) < \left(\frac{4}{\pi}\right)^r \frac{m!}{m^m} \left| \sqrt{\Delta} \right|,$$

where m is the degree and Δ the discriminant of the field, and r the number of pairs of imaginary fields found among the m conjugate fields, $k^{(1)}, k^{(2)}, \ldots k^{(m)}$. The writer refers to Hilbert, "Bericht über die Theorie der Algebraischen Zahlkörper"; Minkowski, "Geometrie der Zahlen," and Woronoj, "The algebraic integers, which are functions of a root of an equation of the third degree" (translation of Russian title). The tables take up ten pages.—On certain properties of the plane cubic curve in relation to the circular points at infinity, by R. A. Roberts, contains an investigation of some methods of generating a plane cubic curve.—With this opening number is presented an excellent portrait of Dr. George Salmon, and a supplement gives a still more excellent one of Prof. Mittag Leffler.—Prof. Frank Morley is the editor in chief.

Bulletin of the American Mathematical Society, January.—Prof. Lovett gives an account of the proceedings at the International Congress of Philosophy, which was held at Paris on August 1–5, 1900, and furnishes *résumés* of the papers read and the discussions occasioned by them, so far as they bore, more or less directly, upon mathematical questions. The sketch is founded upon the account printed in the September (1900) number of the *Revue de Métaphysique et de Morale*. It occupies pp. 157–183.—A demonstration of the impossibility of a triply asymptotic system of surfaces, by Dr. Eisenhart, was read before the Society on December 28, 1900. It is a notelet founded upon Bianchi's Lezioni.—Prof. E. W. Brown writes short notices of Berry's "Short History of Astronomy" and of H. Suter's "Die Mathematiker und Astronomen der Araber und ihre Werke." This latter, though only a catalogue of over five hundred names of mathematicians and astronomers, and so at first sight not giving promise of much interest, is really, as Prof. Brown shows, a work of considerable interest. He illustrates this statement by a few extracts.—There are a fair amount of notes and new publications.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, February 22.—Prof. S. P. Thompson, president, in the chair.—A paper on how air subjected to X-rays loses its discharging property, and how it discharges electricity, by Prof. Emilio Villari (Hon. Fellow), was read by the chairman. Air made active by X-rays in passing through a long tube coiled in many turns loses much more of its discharging power than it does in passing through the same tube if straight. During this process the tube charges itself to a certain potential. If active air is allowed to stream on masses of wire gauze or wound up ribbons, enclosed in tubes, the metals, independent of their nature, take a positive or negative charge according to whether the active air rubs against them with force or lightly. Experiments have been performed to prove this. For instance, tubes of copper or lead, if short and straight, take negative charges, but if long and coiled they take positive charges. These phenomena cannot be attributed to chemical actions, but seem to be produced by a special rubbing of the active air upon metallic surfaces, as the result of which they assume one of the charges, and the other charge ought to manifest itself in the air. This is not the case, the charge of the air being often of the same kind as that of the metals. It has previously been shown by the author that active air by streaming against an electrified body is reduced either to ordinary air or to air charged with the electricity which disappears. Hence it may be supposed that the active air in rubbing upon the metallic surfaces develops the two electricities, one of which manifests itself upon these surfaces, and the other goes to reduce the active air to ordinary air, and therefore does not become manifest. The electroscope used in the experiments consisted of a fixed brass plate and a gold leaf whose position was determined by means of a telescope with an eye-piece scale.—The chairman said he had observed the fact that metals were charged sometimes positively and sometimes negatively by active air. Mr. Watson asked if any experiments had been performed on the viscosity of gases rendered active by X-rays.—A paper on the propagation of cusped waves and their relation to the primary and secondary focal lines, by Prof. R. W. Wood, was read by Mr. Watson. This paper is a discussion of the reflexion of a plane wave by a hemispherical mirror, the reflected wave being likened to a volcanic cone. The cusp of the wave, or the rim of the crater, traces the caustic and is continuously passing through a focus. This accounts for the increased illumination along the caustic. The wave fronts were drawn by constructing the orthogonal surface, which in section is an epicycloid. The evolute of this curve is the caustic, and the reflected wave fronts form a family of parallel curves which are the involutes of the caustic. The wave front between two focal lines is expanding along one meridian and contracting along a meridian at right angles to it; in other words, the wave is convex along one meridian and concave along the other. The outer slope of the volcanic cone representing the reflected wave corresponds to the portion of the wave front between the focal

lines. A useful piece of apparatus can be made by silvering the outside of a hemispherical glass vessel. The concave mirror thus formed should be mounted on a stand, and a small electric lamp arranged so that it can move along the axis of the mirror. A spherical wave starting at the focus of a hemispherical mirror is reflected as a saucer-shaped wave, the curved sides of the saucer coming to a focus in a ring surrounding the nearly flat circular bottom. If the lamp is placed at the focus the luminous ring and the uniformly illuminated area within it can be shown on a ground glass screen. If the lamp be moved to a point midway between the focus and the mirror, a ring of intense brilliance, with very little light within it, is formed.—A paper on cyanine prisms, by Prof. R. W. Wood, was read by Mr. Watson. Prof. Wood has already described a method of making prisms of solid cyanine by pressing the fused dye between plates of glass. Until recently, angles of about half a degree were the largest that could be used with advantage on account of the small quantity of green light transmitted. A new supply of the dye has been found to transmit a large quantity of green light with an angle of over one degree. By viewing the filament of an incandescent electric lamp through one of these prisms the anomalous spectrum is seen, the colours being arranged in the order green, blue, violet, red, orange. Prof. Wood has crossed one of these prisms with a photographic copy of a diffraction grating having 2000 lines to the inch. On viewing a naked arc lamp the diffraction spectra are deviated by the prism, the red ends being turned up and the blue-green ends turned down.—The chairman said he had been trying to obtain some cyanine, but had not succeeded. Rosaniline has an anomalous dispersion, but cannot be fused. The acetate of rosaniline might, however, be used. The Society then adjourned until March 8.

Chemical Society, February 7.—Prof. Thorpe, president, in the chair.—The action of hydrogen bromide on carbohydrates, by H. J. H. Fenton and M. Gostling. The authors, having previously shown that bromomethylfurfuraldehyde results from the action of hydrogen bromide on lævulose, sorbose, inulin or cane sugar, now show that all forms of cellulose give large yields of the same bromomethylfurfuraldehyde under similar conditions; since the formation of this substance is characteristic of ketohexoses or of substances which give rise to them by hydrolysis, it seems conclusively proved that cellulose contains a nucleus similar to that of lævulose.—The ketonic constitution of cellulose, by C. F. Cross and E. J. Bevan. The authors contribute a statement of the evidence, other than that contained in the previous paper, in favour of the supposition that lævulose or some other ketose is the raw material used in the plant for the elaboration of cellulose.—Note on a method for comparing the affinity values of acids, by H. J. H. Fenton and H. O. Jones. The authors have shown that oxalacetic phenylhydrazone is decomposed on heating with water, giving carbon dioxide and pyruvic hydrazone, whilst on heating with acids, pyrazolone carboxylic acid and water are produced in accordance with the following equations:—

$$\begin{array}{c} CH_2.CO_2H \\ | \\ C:N_2HPh \\ | \\ CO_2H \end{array} = \begin{array}{c} CH_3 \\ | \\ C:N_2HPh + CO_2. \\ | \\ CO_2H. \end{array}$$

$$\begin{array}{c} CH_2.CO.OH \\ | \\ C:N.NHPh \\ | \\ CO_2H \end{array} = \begin{array}{c} CH_2.CO \\ | \quad\ | \\ C:N.NPh + H_2O. \\ | \\ CO_2H \end{array}$$

It is shown that, on heating with acids, the volumes of carbon dioxide evolved are in the inverse order of the affinity values of the acids used, other conditions remaining the same.—Organic derivatives of phosphoryl chloride and the space configuration of the valencies of phosphorus, by R. M. Caven. The author has prepared substituted phosphoryl chlorides of the form $OP\begin{cases} R_1 \\ R_2 \\ R_3 \end{cases}$, in which the groups R_1, R_2 and R_3 are ethoxyl and the anilido- and paratoluido-residues respectively; the same substance is obtained irrespective of the order in which the substituting groups are put into the molecule, and the author therefore concludes that these three groups are similarly situated with respect to the rest of the molecule.—α-Hydroxycamphorcarboxylic acid, by A. Lapworth and E. M. Chapman. A method for the preparation of camphorquinone in quantity is given, and it is shown that this substance reacts with hydrogen cyanide to form a mixture of stereoisomeric α-hydroxycyanocamphors, $C_8H_{14}\begin{cases} C(OH).CN \\ | \\ CO \end{cases}$; this substance behaves as an α-hydroxynitrile, and may be hydrolysed to α-hydroxycamphorcarboxylic acid, $C_8H_{14}\begin{cases} C(OH).CO_2H \\ | \\ CO \end{cases}$.—The bacterial decomposition of formic acid, by W. C. C. Pakes and W. H. Jollyman. The authors show that certain bacteria decompose formic acid as sodium formate into equal volumes of carbon dioxide and hydrogen.—Preparation of substituted amides from the corresponding sodamide, by A. W. Titherley.—Note on two molecular compounds of acetamide, by A. W. Titherley.—Diacetamide: a new method of preparation, by A. W. Titherley.—Diacetamide may be directly prepared by the action of acetyl chloride on acetamide.—Organic derivatives of silicon, by F. S. Kipping and L. L. Lloyd. Silicon tetrachloride, when treated with one molecular proportion of an alchohol, exchanges one chlorine atom for an alkyloxy-group yielding a substance of the composition $SiCl_3.OR$. The latter, by similar treatment with two other alcohols, can be converted ultimately into a substance of the constitution $SiCl(OR_1)(OR_2).OR_3$.—Isomeric hydrindamine camphor-π-sulphonates. Racemisation of α-bromocamphor, by F. S. Kipping. From the examination of the *dl*-hydrindamine *d*-camphor-π-sulphonate, it is concluded that slight racemisation occurs during the sulphonation of *dα*-bromocamphor.—Tetramethylene carbinol, by W. H. Perkin, jun. Tetramethylenecarboxylic chloride is reduced by sodium and moist ether to tetramethylene carbinol, a colourless oil boiling at 143–144°.

Zoological Society, February 5.—Mr. Howard Saunders, vice-president, in the chair.—Mr. Sclater called attention to the fine specimen of Prjevalsky's Horse (*Equus prjevalskii*) now mounted and exhibited in the gallery of the Muséum d'Histoire Naturelle of Paris, and made some remarks on its structure and peculiarities.—Mr. Oldfield Thomas gave an account of the mammals which Mr. R. I. Pocock and he had collected during a trip to the Balearic Islands in the spring of 1899. Twenty-four species were enumerated and remarked upon, amongst which was a new form of hedgehog, described as *Erinaceus algirus vagans*.—Dr. W. G. Ridewood read a paper on the horny excrescence on the snout of the southern right whale (*Balaena australis*), known to whalers as the "bonnet," in which he showed that the minute structure is the same in essential features as that of the *stratum corneum* of the normal skin of the whale. The cuticular fibres were set at right angles to the surface, and were not sharply differentiated or readily separable. Comparisons were drawn by the author between the structure of this horny excrescence and that of the nasal horn of the rhinoceros, the hoof of the horse, the horn of the ox and the baleen of the whale.—Mr. G. A. Boulenger, F.R.S., enumerated the species of batrachians and reptiles represented in a collection made by Dr. Donaldson Smith in Somaliland in 1899. Of the reptiles two were new to science and were described under the names *Hemidactylus laevis* and *H. barodanus*.—Mr. Sclater made some additional remarks on the two pieces of zebra-skin, exhibited at a previous meeting, which had been sent to him by Sir H. H. Johnston, K.C.B., from the Semleki Forest on the borders of the Uganda Protectorate, and expressed his opinion that they belonged to a hitherto unknown species, for which he proposed the provisional name of *Equus johnstoni*.—Mr. J. L. Bonhote read a paper on a second collection of Siamese mammals made by Mr. Th. H. Lyle, consul at Nau, Siam. The collection, although small, was of considerable interest, the twenty specimens composing it being referable to eleven species, one of which, *Sciurus macclellandi kongensis*, was described as new. Mr. Bonhote also communicated a paper containing an enumeration of the 139 species of birds of which specimens had been collected during the "Skeat Expedition" to the Malay Peninsula in 1899–1900.—Mr. F. E. Beddard, F.R.S., described a new species of freshwater annelid, under the name of *Bothrioneuron iris*, from specimens obtained in the Malay Peninsula during the "Skeat Expedition" in 1899–1900.

Entomological Society, February 6.—The Rev. Canon Fowler, president, in the chair.—The president exhibited a specimen of *Colias edusa* var. *helice*, with the margins of the

wings entirely dark, as in the male; also a variety of *Cartero-cephalus palaemon*, with the hind wings dark save for one conspicuous orange spot.—Dr. T. A. Chapman exhibited a large series of Endrosæ, collected during the last few years by himself, Mr. A. H. Jones, and especially by Mr. Tutt, showing the relative approximation of the several species. Except *irrorella* from England, Finmark, and the Tyrol, and a few *aurita* from the Tyrol, all were from the Western Alps of Switzerland, Italy and France. Examples from each locality, he said, when sufficiently numerous usually have a special facies. Some, as all those from Arolla, radiate; those from Bourg St. Maurice are without radiate forms, and so on. Some are more yellow; others deeper orange; some more mixed. Elevation tends to produce radiation, but no other general conclusion as to the effect of height, latitude or longitude seems fully justified by the specimens.—Mr. G. C. Barrett exhibited for Mr. G. O. Day, of Knutsford, a black variety of *Aplecta nebulosa*, Tr., with white cilia, and an asymmetrical ♀ var. of *Fidonia atomaria*, Linn.—Mr. M. Jacoby exhibited an unknown specimen of the family Halticidæ.—Mrs. Nicholl exhibited a collection of Rhopalocera from the Lebanon district of Syria, and Mr. H. J. Elwes, on her behalf, read a paper explaining and illustrating the several species included. Among other species Mr. Elwes drew especial attention to *Thecla myrtale*, which, since it was described by Klug in 1832, has remained one of the least known members of the palæarctic fauna. No specimens, it appears, had been taken in the interval until Mrs. Nicholl found it on the high mountains not uncommonly in May and June.—The following papers were communicated:—A revision of the genus Astathes, Newm., and allied genera of Longicorn Coleoptera, by C. J. Gahan, M.A., and a preliminary catalogue of the Lepidoptera-Heterocera of Trinidad, by W. J. Kaye.

Linnean Society, February 7.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. H. W. Monckton exhibited some lantern-slides showing a large ammonite in the Kimmeridge clay at Swanage, and several views taken at the Pentland oyster-bed at Tilly Whim, and the Purbeck oyster-bed in Durleston Bay.—The president, whilst demonstrating the property possessed by certain vegetable liquids, such as coconut milk and the juice of the pineapple and the potato, to cause the oxidation of guaiacum tincture in the presence of hydrogen peroxide, a blue colour being produced, drew attention to the recent researches of Raciborski on the subject. Raciborski has made the interesting discovery that certain tissues of the plant-body, more particularly the sieve-tubes and the laticiferous tissue, contain some substance, to which he gives the name *leptomin*, which likewise causes guaiacum to turn blue in the presence of hydrogen peroxide, and has gone on to infer that this leptomin may be regarded as discharging in the plant a function analogous to that of hæmoglobin in the animal body. The president urged, against this assumption, that although both leptomin and hæmoglobin give the guaiacum reaction, yet this fact does not prove that leptomin can combine with oxygen, and can act as an oxygen-carrier in the organism, in the manner which is so characteristic of hæmoglobin; and that, therefore, the suggested analogy between the two substances is at least premature.—Mr. H. M. Bernard read a paper, of which an abstract had been previously circulated, on the necessity for a provisional nomenclature for those forms of life which cannot be at once arranged in a natural system. A discussion followed in which Prof. Ray Lankester, Sir W. T. Thiselton-Dyer, Mr. Bateson, Mr. Elwes, and Prof. Jeffery Bell took part. It was proposed by Prof. Lankester, and seconded by Mr. H. J. Elwes, that the discussion be adjourned to another meeting, and that resolutions be framed for submission to that meeting when called.

Anthropological Institute, February 12.—Prof. Haddon, F.R.S., in the chair.—Mr. A. L. Lewis, treasurer of the Institute, showed slides illustrative of the recent damage to Stonehenge.—A paper was read on Malay metal-work, by Mr. Walter Rosenhain. The paper dealt with some specimens of Malay metal-work submitted to the author for microscopic and other examination by Mr. W. W. Skeat.—Some Malay processes actually witnessed by Mr. Skeat were described, and the bearings of the microscopic examination on the explanations of these processes were discussed. The first question dealt with was the production of the "damask" pattern on a Malay kris. Microphotographs were given showing that the "damask iron" really consists of layers of loosely welded wrought iron, the only other metal used being tool steel. The body of the blade is made of steel and a layer of laminated "damask iron" is welded upon either side of the central layer of steel; a thin layer of steel is welded on outside the "damask iron." The author believes that the striated "damask" effect is due to the opening of the loose welds in the damask iron during the forging of the blade, steel being driven between the laminæ. The outside layer of steel is entirely ground away, and when the compound surface so produced is "etched" by the pickling process employed, the more readily corroded steel is attacked, leaving the edges of the layers of iron as a series of narrow projected ridges.—The final section of the paper dealt with the Malay method of producing chains by casting, and was illustrated by some successful experiments.

Mathematical Society, February 14.—Dr. Hobson, F.R.S., president, in the chair.—Dr. Larmor, F.R.S., gave an abstract of a paper by Mr. T. Stuart, entitled "The Distribution of Velocity and the Equations of the Stream Lines, due to the Motion of an Ellipsoid in Fluid Frictionless and Viscous."—Lieut.-Colonel Cunningham communicated a paper on factorisable twin binomials. Mr. C. E. Bickmore spoke on the subject.—Mr. Tucker gave an account of the brocardal properties of some associated triangles.—The following papers were communicated by the president: Concerning the Abelian and related linear groups, by Dr. L. E. Dickson.—A geometrical theory of differential equations of the first and second order, by Mr. R. W. Hudson.—A note on stability, with a hydrodynamical application, by Mr. Bromwich.—Remarks on notation in Lie's theory of groups, and on Schur's determination of a continuous group of given structure, with remarks on Mr. Campbell's paper (read at the January meeting), by Mr. H. F. Baker, F.R.S.; and a note on curves similar and parallel to one another, by Mr. D. B. Mair.

CAMBRIDGE.

Philosophical Society, February 4.—Prof. Macalister, president, in the chair.—Geometrical notes, by the Master of St. John's College. These notes give simple proofs of Halley's construction for the normal or normals from a given point to a parabola, and Frégier's theorem that a chord of a conic which subtends a right angle at a fixed point of the curve passes through a fixed point on the normal thereat.—On the interference bands produced by a thin wedge, by Mr. H. C. Pocklington. The interference bands produced when monochromatic light from a small but finite source falls obliquely on a thin wedge of slightly reflecting material are investigated. It is shown that if the incident light is a parallel beam, the bands do not lie in the wedge, but in the air in a plane passing through the edge of the wedge and perpendicular to the reflected light, and that the distance between consecutive bands is $\lambda/2a$.—On some rare and interesting fungi, collected during the past year, by Prof. Marshall Ward.—On geotropism, by Mr. F. Darwin. The experiments described were directed to the question whether or not the tip of the root is the region where the gravitation stimulus is perceived. The germinating seeds were so placed that the tip of the root was fixed in the horizontal position, while the base of the root together with the seed could move. Since the supposed sensitive region remains horizontal, it was expected that the motor region of the root would continue to curve in response to the continued stimulation of the tip. This was found to be the case. But the great technical difficulties of the method and certain difficulties of interpretation render the evidence less striking than might have been hoped.—Notes on artificial cultures of Xylaria, by Miss E. Dale (communicated by Prof. Marshall Ward). Two species were cultivated from ascospores and grew equally well on pieces of the sterilised wood of beech, oak and silver fir, on which they produced several types of conidiophores.—The mycelium penetrates into all the tissues of the wood which forms its substratum, passing from cell to cell through the pits. Its action on the wood fibres is peculiar. Straight hyphæ pass down the lumen and give off branches which penetrate the pits and grow spirally, each lying in a channel which it has made in the cell-wall, apparently by excreting some wood-destroying enzyme.—The habits and development of some West African fishes, by Mr. J. S. Budgett. The paper gave an account of a part of the material obtained during a recent visit to the Island of McCarthy on the Gambia river, in order to investigate the development of *Polypterus*. The young larva of *Polypterus lapradii*, Steind., was described which had not yet developed the bony scales on the body. The nests and larvæ of *Protopterus annectens*, Ow., were described and the development shown to

be remarkably similar to that of *Lepidosiren*. The floating nests and the development of *Gymnarchus niloticus*, Cuv., were described and also the very large nests and the larvæ of *Heterotis niloticus*, Cuv. The larvæ of both these forms possess externally produced gill-filaments, while the development of *Gymnarchus* is in some respects shark-like. Two other forms, *Sarcodaces odoë*, Bl., and *Hyperopisus bebe*, Lacep., were shown to possess in the larval condition well-developed cement organs on the front of the head.—On a new form of microtome, by Mr. H. M. Leake (communicated by Mr. A. E. Shipley.)—The ignoration of coordinates, by Mr. T. J. I'A. Bromwich.—A theorem on curves belonging to a linear complex, by Mr. J. H. Grace.

DUBLIN.

Royal Dublin Society, December 19, 1900.—Prof. W. N. Hartley, F.R.S., in the chair.—Prof. E. A. Letts and Mr. R. F. Blake read a paper (communicated by Dr. W. E. Adeney) on a simple and accurate method of estimating the dissolved oxygen in fresh water, sea water and sewage effluents.—Mr. E. St. John Lyburn read a paper (communicated by Prof. W. N. Hartley) on prospecting for gold in the county of Wicklow, with an examination of Irish rocks for gold and silver. The author deals with the history of the discovery of gold in Ireland, and more especially with the results of a six months' prospecting tour in the county of Wicklow. One hundred and ten samples were taken and subjected to assay, the highest assay giving 4 dwts. pure gold per ton (2240 lbs.); this sample was obtained from a quartz vein, about eight inches wide, on the Croghan Kinshelagh mountain, and in the immediate vicinity of the Government workings of 1798. The author expressed the view that the locality he explored was worthy of further attention.

January 16, 1901.—Dr. W. E. Adeney in the chair.—Prof. Hugh Ryan read a paper on the preparation of amidoketones; and Prof. E. A. Letts and Mr. R. F. Blake communicated a paper on some problems connected with atmospheric carbonic acid, and on a new and accurate method of determining its amount, suitable for scientific expeditions.

PARIS.

Academy of Sciences, February 18.—M. Fouqué in the chair.—On a new form of the equations of mechanics, by M. H. Poincaré.—On the secondary radio-activity of metals, by M. Henri Becquerel. Metals receiving the direct rays from a radio-active substance appear to give off a secondary radiation. The penetrating power of this secondary radiation is more feeble than that of the primary rays, and is analogous to the same property of the secondary Röntgen rays discovered by M. Sagnac. The effect of this is that a metallic plate, placed upon a photographic plate, instead of acting as a screen to arrest the radiation from the source, gives, on the contrary, a stronger impression.—On a new gaseous compound, sulphuryl fluoride, SO_2F_2, by MM. Moissan and P. Lebeau (see p. 426).—On the alkyl cyanomalonic esters and the alkylcyanacetic acids derived from them, by MM. A. Haller and G. Blanc. It is shown that cyanomalonic ester contains the group CH, and that the substitution of alkyl radicles takes place on this atom of hydrogen, since in all the derivatives obtained from it the radicles are united to the carbon atom of the group CH.—Note on a congenital lacrymopharyngo-facial fistula, open below the left nostril, by M. Lannelongue. A description of a congenital fistula representing, in the form of an anomaly, a transition state in development. The case has an important bearing upon the theory of the development of the human embryo, and would appear to be in direct contradiction to the views of Albrecht on the development of the nose and upper lip. The operation described effected a complete cure.—On the discovery of a sea urchin of the Cretacean age in the eastern Sahara, by M. de Lapparent. The fossil described, which was found accidentally by Colonel Monteil at Zau Saghair, near Bilma, has been recognised by M. Victor Gautier as belonging to the same genus as an echinoderm discovered in the upper layers of the Cretacean in Baluchistan. It is thus proved that towards the end of the Cretacean epoch, about the time when in Europe the sea underwent such a marked retrogression, not only did it persist in the Lybian Desert, but it advanced to the neighbourhood of Tchad, manifesting by its fauna affinities with the Indian region.—On the propagation of waves in viscous fluids, by M. P. Duhem.—Observations on the variability of the planet 433 Eros, made at the Observatory of Toulouse with the 23-cm. Brunner equatorial, by M. F. Rossard.—On the luminous variability of Eros, by M. Ch. Andre (see p. 426). From the photometric observations, it is concluded that the planet is formed of a double system of two asteroids, of which the diameters are very nearly in the ratio of three to two, and whose orbital plane passes through the earth.—On the deformation of the paraboloid, by M. C. Guichard.—On the problem of the isoperimeters, by M. A. Hurwitz.—On functions of two variables analogous to modular functions, by M. R. Alexais.—On a new micrometer eye-piece, by M. L. Malassez.—On the specific absorption of the X-rays by metallic salts, by MM. Alexandre Hebert and Georges Reynaud. Results are given for experiments on the relative specific absorption of a series of metallic nitrates, from which it is shown that, in general, the absorption of the X-rays by the nitrates becomes greater with the increase in the atomic weight of the combined metal. The curve for the specific absorption plotted against the atomic weights as abscissæ is practically an equilateral hyperbola.—On hydrocinchonine, by MM. E. Jungfleisch and E. Leger. The substance previously obtained by the authors by the action of dilute sulphuric acid upon cinchonine and described by them as cinchonifine, is now shown to be identical with the hydrocinchonine of Caventou and Willm.—On diphenylcarbodiazine, by M. P. Cazeneuve.—On a new alcohol derived from limonene, by M. P. Cazeneuve. The new alcohol, named limoneol, is prepared by the action of peroxide of nitrogen upon limonene. It is a secondary alcohol, like pinenol, and gives a ketone on oxidation with chromic acid mixture.—The transformation of dimethylacrylic acid into dimethylpyruvic acid, by MM. Bouveault and A. Wahl. If the aminodimethylacrylate of ethyl, the preparation of which is described in a previous paper, is heated with aqueous hydrochloric acid, ethyl dimethylpyruvate is produced, the oxime and semicarbazone of which were prepared for the purpose of identification.—Action of the monohalogen acids of the fatty series upon pyridine and quinoline, by MM. L. J. Simon and L. Dubreuil.—On the pyrogallolsulphonic acids, by M. Marcel Delage.—The reserve hydrocarbon in the tubercles of *Arrhenathererum bulbosum*, by M. V. Harlay. The tubercles on extraction with dilute alcohol yield 4·8 per cent. of a carbohydrate, which on hydrolysis with dilute sulphuric acid gives pure lævulose. The original substance differs from inulin in solubility and rotatory power.—Nervous transmission of an instantaneous electric stimulus, by M. Aug. Charpentier. From the researches described it follows that an electrical stimulus may give rise to a double transmission on the part of the nerve, one part being transmitted nearly instantaneously, like an ordinary conductor, with a velocity too great to be measured in the usual way, the other part of the stimulus is transmitted, always electrically, with the very moderate velocity of about 20 to 30 metres per second.—The physiological action of wine, by M. L. Roos. From experiments on guinea-pigs the author concludes that the daily use of wine with the food, even in relatively large proportions, exerts no unfavourable effect.—The luminescence obtained with certain organic compounds, by M. Raphael Dubois. In presence of alcoholic potash a considerable number of organic substances become luminescent. The reaction may be of some service in the qualitative analysis of certain essential oils.—The nucleated red blood corpuscle behaves like a vegetable cell, from the point of view of osmosis, towards urea in solution, by M. R. Quinton.—On the absorption of monocalcium phosphate by arable earth and humus, by M. J. Dumont.—Observations relating to the propagation in apple orchards of *Nectria ditissima*, by M. Descours-Desacres. Nicotine, tannin and tannic acid have proved to be the most efficacious remedies against this disease.—On the petrographical province of the north-east of Madagascar, by M. A. Lacroix.—On a mass of metallic iron which was said to have fallen from the sky in the Soudan on June 15, 1900, by M. Stanislas Meunier.—Concerning the mineral layers of oolitic iron of Lorraine and their mode of formation, by M. Georges Rolland.

ST. LOUIS.

Academy of Science, January 21.—Rev. M. S. Brennan read a short sketch of the progress of astronomy in the United States, in which the material equipment and the discoveries made during the past century were passed in review.—A paper by Prof. T. G. Poats, entitled "Isogonic Projection," was presented in

abstract.—Prof. F. E. Nipher showed, by means of the lantern, a series of negatives printed by contact from a lantern slide or positive picture by the light of a 300-candle incandescent lamp. The unit of exposure adopted was one lamp-metre-second. The exposures varied from 0·0054 to 4800. All were developed in the dark-room with hydrochinon, those above 0·1 exposure having in the bath one drop of saturated hypo to the ounce of bath. The plate having an exposure of 0·1 seemed to be normally exposed. An exposure 210 gave a negative showing some fogging, but a print from it by ordinary methods gave a very satisfactory result. With longer exposures, the plate began to reverse, locally. With an exposure of 3600, which was an exposure of one hour at a distance of one metre from a 300-candle lamp, half of the plate still showed as a negative. The shadow on the gown of a figure in the landscape showed white as a negative, and the part of the gown in sunshine showed white as a positive. The penumbra between light and shadow was darker. All the details were sharp, but lights and shadows were somewhat incongruous. With an exposure of 4800 the details had not yet all reversed, but the greater part of the plate had become a positive. The greatest exposure giving a negative which would yield an acceptable print was 210, which was 39,000 times the least exposure which would give a good negative. All exposures of 210 and over gave complete positives when the plates were developed 1·41 meter from a 16-candle lamp, or in stronger light. As good a picture as has been obtained had an exposure of 4800, and was developed within half a meter of a 300-candle lamp. A fair picture had even been obtained from a two-hour exposure to direct sunlight with a Cramer "Crown" plate. It was stated that hypo in the developing bath did not affect the zero condition, or change the character as to positive and negative. When no hypo is used, the plate fogs so quickly that the picture is invisible before it has time to fully develop. After fixing, the thin shadowy picture showing on the fogged plate has the same local positive and negative characters that are shown on the clearly defined picture of the same exposure when developed in the hypo-hydrochinon bath. The greatest exposures giving good results that have been measured with reasonable accuracy were about 900,000 times as great as the least exposure giving a good negative in the dark-room. This factor can certainly be trebled. A plate having any intermediate exposure can be developed either as a good positive in the light or as a good negative in the dark-room.

DIARY OF SOCIETIES.

THURSDAY, February 28.

Royal Society, at 4.30.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. IV. The Seed-like Fructification of *Lepidocarpon*, a Genus of Lycopodiaceous Cones from the Carboniferous Formation: Dr. D. H. Scott, F.R.S.—A Preliminary Account of the Development of the Free-swimming Nauplius of *Leptodon hyalina*, Lillj.: Dr. E. Warren.—On the Result of Chilling Copper-Tin Alloys: C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.—On the Theory of Consistence of Logical Class-frequencies, and its Geometrical Representation: G. Udny Yule.

Society of Arts, at 4.30.—Railways and Famine: Horace Bell.

Institution of Electrical Engineers, at 8.—Conclusion of discussion on Mr. Madgen's paper.—Followed, if possible, by Cables: M. O'Gorman.

FRIDAY, March 1.

Royal Institution, at 9.—Enamels: H. H. Cunynghame.

Geologists' Association, at 8.—The Post-Pliocene Non-Marine Mollusca of the South of England: A. S. Kennard and B. B. Woodward.—The Pleistocene Fauna of West Wittering, Sussex: J. P. Johnson.

SATURDAY, March 2.

Royal Institution, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

MONDAY, March 4.

Society of Arts, at 8.—The Bearings of Geometry on the Chemistry of Fermentation: W. J. Pope.

Victoria Institute, at 4.30.—A Visit to the Hittite Cities, Eyuk and Boghas: Rev. G. E. White.

TUESDAY, March 5.

Royal Institution, at 3.—The Cell as the Unit of Life: Dr. Allan Macfadyen.

Zoological Society, at 8.30.—On some Extinct Reptiles from Patagonia, of the Genera *Mioannia*, *Dinilysia*, and *Genyodectes*: Dr. A. Smith Woodward.—Note on the Innervation of the Supra-orbital Canal in *Chimaera monstrosa*: R. H. Burne.—Contributions to the Knowledge of the Structure and Systematic Arrangement of Earthworms: F. E. Beddard, F.R.S.

Institution of Civil Engineers, at 8.—Discussion of paper on the Rotatory Process of Cement Manufacture: W. H. Stanger and Bertram Blount.—Ballot for Members.

WEDNESDAY, March 6.

Society of Arts, at 8.—Modern Artillery: Lieut. Arthur Trevor Dawson.

Geological Society, at 8.—Recent Geological Changes in Central and Northern Asia: G. F. Wright.—The Hollow Spherulites of the Yellowstone and Great Britain: J. Parkinson.

Society of Public Analysts, at 8.—The Determination of Dissolved Oxygen in Water in Presence of Nitrites and Organic Matter: Dr. S. Rideal.—Some Analyses of Oatmeal: Dr. Bernard Dyer.—The Detection and Estimation of Preservatives in Milk: M. Wynter Blyth.

THURSDAY, March 7.

Royal Society, at 4.30.

Linnean Society, at 8.—A Contribution to the Fresh-water Algæ of Ceylon: Messrs. W. West and G. S. West.—On Mediterranean Malacostraca: A. A. Walker.

Institution of Electrical Engineers, at 8.—Insulation on Cables: M. O'Gorman.

Chemical Society, at 8.—(1) Nomenclature of the Acid Esters of Unsymmetrical Dibasic Acids; (2) Additive Compounds of α- and β-Naphthylamine with Trinitrobenzene Derivatives; (3) Acetylation of Arylamines: J. J. Sudborough.—Formation of Amides from Aldehydes: R. H. Pickard and W. Carter.

Röntgen Society, at 8.—Exhibition of Skiagrams and Apparatus.

FRIDAY, March 8.

Royal Institution, at 9.—Vitrified Quartz: W. A. Shenstone, F.R.S.

Royal Astronomical Society, at 5.

Institution of Civil Engineers, at 8.—Sewage Treatment: C. Johnston.

SATURDAY, March 9.

Royal Institution, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

CONTENTS.

THURSDAY, MARCH 7, 1901.

THE PRESENT ASPECT OF SOME CYTOLOGICAL PROBLEMS.

The Cell in Development and Inheritance. By E. B. Wilson, Ph.D., Professor of Zoology, Columbia University. Second edition, revised and enlarged. Pp. xxi + 483. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.) Price 14*s.* net.

DURING the few years which have elapsed since the appearance of the first edition of Prof. Wilson's book on the cell, the rapid accumulation of new facts has resulted in the modification, in many important respects, of the views which were entertained concerning many cell phenomena even so lately as five years ago. Hence, though the volume before us is issued as a second edition, it has not only been considerably enlarged, but also much of the original matter has been displaced to make room for new treatment which shall more faithfully reflect the attitude of cytologists towards the problems which confront them at the present time. And we may fairly say that the author's efforts have not only been largely successful, but they have resulted in the production of one of the best works which it has been our good fortune to meet with for a long time.

The whole subject is handled in an easy and masterly fashion, and the reader is enabled readily to grasp the leading facts and to obtain a clear insight into the nature of the chief questions of cytological importance. Of course the book is not without its faults, but they are not, for the most part, serious ones. The author is naturally less at home when dealing with botanical than with zoological work, and indeed he says as much in his preface; but we notice, here and there, slips which might have been easily avoided. Amongst the most obvious of these is a somewhat misleading account of the morphology of the embryo-sac on pp. 264-5. A more trifling matter is the rather irritating recurrence of eulogistic adjectives, and the reader is apt to weary of a "brilliant" hypothesis or an "interesting" observation which is shown a few lines farther on to be untenable or unsound.

The volume opens with a brief historical introduction, in which it is satisfactory to find that to Cohn is given the credit, which undoubtedly belongs to him, of having been the first clearly to identify sarcode with protoplasm. Then follow chapters on the division of the cell and the nucleus, and of the more intimate structure of the cell-constituents. In the account of the details of karyokinesis, a fairly representative series of examples is given; but we could have been well contented had the author seen fit to amplify his treatment of the simpler and more primitive forms of life, seeing that so many of them exhibit remarkable and suggestive deviations from the course of events as pursued in the higher animals and plants.

Prof. Wilson deals with the vexed questions which have arisen concerning the centrosome in a cautious and discriminating manner, and he discusses the various theories which have been put forward respecting the nature and functions of this highly enigmatical body. A considerable mass of evidence has been gradually accumulating which tends to show that a greatly exaggerated importance has been assigned to it by many investigators. There are instances in which it can only be recognised as a transitory structure which persists during special phases of activity, to disappear when these subside. The view was at one time current amongst the majority of cytologists that the centrosome represented a permanent structure which presided over the divisions of the nucleus, and that it was, in fact, *par excellence* the organ which aroused and directed the karyokinetic processes. More extended investigation has, however, failed to support this proposition, and in not a few cases, especially amongst the higher plants, there is no good evidence of the existence of a centrosome at all. Furthermore, the researches of Hertwig, Morgan, and especially the recent ones of Loeb, have proved that eggs in which the original centrosomes have undergone complete degeneration are yet capable of exhibiting the entire processes of division when appropriately stimulated, and this without the entrance of a sperm or any other centrosome-bearer whatsoever.

The question as to the permanence of the chromosomes is also considered, and, on the whole, Prof. Wilson appears to incline to the view that the *same* chromosomes which were visible in the daughter nuclei at the close of a division reappear when the latter proceed to divide once more. In conformity with this idea, he supports the hypothesis that in cases where less than the normal number of chromosomes arise in a nucleus, these are in reality plurivalent—that is, each apparent chromosome is compound, and represents two (or more) true chromosomes united together, although their individuality may be for the time entirely masked. Thus it is well known that the nuclei of both the ovum and the spermatozoon possess only half the number of chromosomes characteristic of the somatic cells of the organism, and that this "reduction" is accomplished in connection with two peculiar and rapidly-succeeding nuclear divisions. Each of these chromosomes (at least in the first division) is then regarded as plurivalent (bivalent)—that is, as composed of, at any rate, two individuals which have not separated from each other. One necessary consequence of this view is that somewhere during one of these divisions, or at any rate before the formation of the sexual cells which arise from them, there must be a *qualitative* distribution of the real primary chromosome-individuals between two nuclei. Such an occurrence was regarded as antecedently probable by Weismann, and his views received a remarkable confirmation at the hands of several investigators, who describe the sequence of events as proceeding in a manner such as to render it apparently clear that a qualitative distribution does actually occur.

On the other hand, many others have been unable to find any evidence for the existence of such a type of division in other organisms, and conclude that the facts are strongly opposed to it. Should their view be correct, even in the case of a single example, the whole objective

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evidence relied on by those who see in the phenomenon of chromosome-reduction a confirmation of Weismann's theory falls to the ground. And with it, also, the hypothesis of plurivalency and continued persistence of the chromosomes suffers a serious limitation, for it is obvious that a time must soon arrive, in the sequence of generations, at which the evident chromosomes themselves can no longer consist of the telescoped chromosome units of all the previous life-cycles. In short, each chromosome that appears after the reduction in number cannot be represented in terms of the somatic units as $a+b$, but it must possess a new structure c.

Prof. Wilson very fairly reviews the evidence for and against a *qualitative* reduction (of the quantitative or numerical reduction there is, of course, no question), leaning, as has been said, somewhat in its favour, and it must be admitted that there is some indirect evidence in support of it. Perhaps it hardly falls within the scope of the author's work, but a consideration of the reversion of hybrids to the original stocks, such as indicated by Mendel's law, which has recently formed the subject of important communications by De Vries and by Correns, might have been discussed in this connection.

Exigencies of space forbid us to do more than to indicate the excellence of the treatment of the structure and development of the spermatozoon, of the phenomena of fertilisation, and of parthenogenesis. Our views as to the essential nature of fertilisation are undergoing a change in certain respects as the result of cytological investigations in this field of inquiry. We have clearly to recognise the existence of two distinct factors in the process. The one is concerned with the stimulation of the egg, which is thereby impelled to segment and to develop into a new organism, the other is involved in the fusion of the two sexual nuclei.

Boveri's experiments long ago showed that a fusion of the male and female nuclei was not essential to the segmentation and organised development of an egg. He succeeded in fertilising non-nucleated fragments of echinoderm eggs with the sperms of another species, with the result that larvæ exhibiting the paternal characters only were formed. These experiments were for some time regarded as not being free from objection, but they have been repeated with similar results. Again, as Loeb has recently shown, it is possible, by treating the unfertilised eggs of *Arbacia* with a solution of magnesium chloride, to cause them when replaced in sea-water to give rise to normal larvæ. And once more, Nathansohn has proved that, in the case of *Marsilea*, a sufficiently high temperature suffices to excite parthenogenetic development in the oospheres of these plants. Even in many normally fertilised eggs it has been repeatedly shown that the stimulus which starts the karyokinetic processes in the egg comes from the cytoplasmic (centrosome) portions of the sperm rather than from its nucleus.

As regards the significance of the nuclear fusion, although we are as yet unable to speak with certainty as to its proximate or efficient cause, there can be little doubt but that its teleological significance is to be sought in the fact that these bodies contain in themselves the physical basis of heredity, and thus by their coalescence the hereditary qualities of both parents are mingled in the offspring.

J. B. FARMER.

METHOD IN PHILOSOPHY.

Die Transzendentale und die Psychologische Methode. Dr. Max F. Scheler. Pp. 181. (Leipzig: Dürr'schen Buchhandlung, 1900.) Mk. 4.

IN opposition to the positivism which avers that if we take care of facts method may be left to take care of itself, Dr. Scheler claims that the history of thought, its continuity notwithstanding, shows abundantly that each fresh conquest in knowledge is preceded by a definite, if often half-conscious, breach with outworn method. Kant's historic mission has been fulfilled, and, after a century's probation, the time has arrived to pass beyond him. Not, however, by the adoption in philosophy of that psychological method which, discredited in Condillac and Hume, has been encouraged by recent advances in technical psychology to essay rehabilitation in more plausible forms. Dr. Scheler is with contemporary psychology in its reaction in favour of real as against formal principles, development as against finality, the historical as against the mathematical temper. He is with the Kantian in his recognition of the *quaestio juris* and in his advocacy of an inverse or "reductive" method. In the result he accepts a formula from Eucken—that of a regress from "the well-founded phenomenon" of a culture embodied in a coherent aggregate of institutions to the real forces of which it is the living and still growing product. *Arbeitswelt* and *Geistige Lebensform* are the catchwords of this "noölogical" method.

Dr. Scheler's discussion of "transcendental" method, *i.e.*, the inference from an accepted group of facts to the principle which can and can alone explain them—what evidence of the "alone" could be adduced it is hard to see—directs its main attack, not against its inverse character, but against (1) its static nature due to acceptance of an immutable starting-point, (2) its formalism in its conclusion to grounds of a merely logical kind, (3) its intellectualism with its consequent neglect of "three-fourths of life." Its alleged "synthetic propositions *a priori*," *i.e.*, propositions at once instructive and necessary, are really experiential. The starting-point is really dependent on psychology. Change the period and get a different psychological "climate," and you will find that the transcendental presuppositions will be different. But if so, the psychological ground-propositions will be complete in themselves, and formal conditions established by transcendental deduction are superfluous. The only regress which is not simply a doubling of the data must be towards real, that is, actual and active principles. And the data are neither unchanging nor purely rational.

This general appreciation Dr. Scheler reinforces by a detailed treatment of space, time, causation, and personality. As regards space, the temptation to strengthen the charge of formalism by putting Kant out of touch with a perceptual world has proved too strong for Dr. Scheler. Kant's "empty" space probably means only that all particular contents of space can severally be thought away without altering our space-apprehension. Kant's space is voidable rather than void. Geometer's space, while it is in one sense an abstraction, is not only not a generic concept, but not a concept at all, if the argument as to whole and parts in Kant's metaphysical exposition is to stand. The psychogenetic problem of the perception of a third dimension is irrelevant to Kant's nativism.

The bearing of "metageometry" upon Kant's doctrine of space is still *sub judice*. It is open to the Kantian to maintain either that "bent" spaces fall within Euclidean space, multidimensional spaces being an hallucination due to abuse of algebraic symbolism, or, with Mr. Bertrand Russell, that if Euclidean space is experiential, yet some "form of externality" is *a priori*. Dr. Scheler is, however, throughout the discussion suggestive, if inconclusive.

Less satisfactory is his treatment of causation. The statement that the conception of uniformity is foreign to the Greek period is absurd. That the period of Roman decay was one of lawless happenings is not true in the sense of p. 73, and Dr. Scheler does not save himself by after qualification, in view of the exaggerated position of p. 69, that the causal category which makes natural science possible as a science of experience would make historical science as a science of experience impossible. The treatment of time and the self is relatively slight.

The inadequacy of the psychological method is to be found in its equivocal use of the term "facts of consciousness." Either it is Protagorean and anarchical, and the objects of all sciences and nesciences are on a dead level of "psychical existence," or there are realities which transcend this accommodating rubric. Idealism is prone to the epistemological fallacy, as positivism is prone to the phenomenalist fallacy.

If, however, neither transcendentalism with its reduction, nor psychology with its grip on something real—even falsities—can satisfy us, we must, in default of other probable courses, cast about for some syncretist formula uniting the truths and discarding the defects of both. Dr. Scheler declines Sigwart's irenicon, because of the primacy it involves of the moral and volitional element in life. Surely this is not ineradicable from Sigwart's formula? Rejecting this, and the solutions of which it is the type, he falls back upon the endeavour of his teacher, Eucken, to make jettison of all in both methods that offends the time-spirit, and to fashion what is left, with the aid of something which both had left out, into a non-absolutist, non-sceptical scheme, hereafter to be more fully developed.

H. W. B.

OUR BOOK SHELF.

First Stage Botany, as Illustrated by Flowering Plants. By Alfred J. Ewart, D.Sc., Ph.D., F.L.S. Pp. viii + 252. (London: W. B. Clive and Co., no date).

THE author sets forth in the preface that his primary object in writing this book was that of satisfying the requirements of students preparing for the elementary stage of the Science and Art Examinations. A glance through its pages suffices to prove that this end is everywhere kept to the fore. Even the figures, which are very numerous, are labelled all over in large type so as to enable the student, with the minimum expenditure of time and trouble, to get up the maximum amount of facts. In the text the treatment is on analogous lines, and probably the student possessed of a good memory might, with this book as his mentor, succeed in passing a fair examination. Beyond this we have failed to discover why the book was written; and when its author goes on to state that it is also intended to serve as an "efficient introduction to Botany," we simply cannot agree with him. The character of the book is too dogmatic, and too little is left to the student. Indeed, a sentence contained in the preface, advising the student to obtain specimens and "verify upon them the statements made in the text," gives the key to the entire book. Not merely verification, but the fostering of a spirit of *inquiry* ought to be the chief aim of a teacher, and it is this aspect of the matter which we miss in the volume before us. In the paragraph on geotropism (p. 211) this phenomenon is defined as the "tendency of the radicle or main root to grow towards the centre of the earth"; a very inadequate definition both from the point of view of fact and theory, and one of little or no scientific value to the student.

Some subjects, *e.g.* obdiplostemony, are introduced which would have been better omitted. Unless fully discussed they are of no value educationally, and the space they occupy would be better taken up by a more extended treatment of the more elementary matters. Although, in a general way, the book much resembles others of its class, save, perhaps, in the compression of an unusually large number of facts into its pages, it is but right to add that actual errors are remarkably scarce.

The Principles of Magnetism and Electricity. An Elementary Text-book. By P. L. Gray, B.Sc. Pp. xvi + 235. (London: Methuen and Co., 1901.) Price 3*s*. 6*d*.

THE number of elementary text-books on magnetism and electricity probably exceeds that of text-books on any other subject. One would, therefore, naturally expect that anybody attempting to add to their number would do so with a due sense of responsibility, and endeavour to produce a book which might be regarded as surpassing those already in existence either in accuracy of exposition or in freshness of treatment. A careful perusal of the book before us has forced us to the conclusion that the author is destitute of all sense of responsibility, and not afraid to scatter error broadcast with a light heart. Seldom has it been our lot to come across an elementary text-book so full of glaring errors so boldly stated. On p. 18 the author describes a vibrational method of comparing the moments of two magnets in which the moments of inertia of the magnets are not even referred to! On p. 15 we have the startling assertion that in the case of diamagnetic bodies "the induced magnetisation is *at right angles to the field*" (the italics are the author's!). Could there be a greater confusion of ideas than that exhibited by the following sentence? (p. 151): "A pole of strength m will have $4\pi m$ lines of force proceeding from it, so that, if a transverse narrow cut be made across a magnet which has σ lines per sq. cm. in any normal cross-section, the field in the narrow slit H will be equal to $4\pi\sigma$." The author measures magnetic force in *dynes*, and difference of potential in *ergs*. On p. 162, in connection with the induction coil, we read: "Trowbridge has recently obtained sparks nearly seven feet in length, obtaining an E.M.F. of 3,000,000 volts, *the primary current being supplied from a battery of* 10,000 *storage cells*" (the italics are ours). Is the author serious, or does he intend playing a practical joke on his reader, by suggesting that any sane person would use 10,000 storage cells for supplying the primary of an induction coil? Had he taken the trouble to refer to Prof. Trowbridge's papers, the author would have found that the arrangement used for obtaining the 3×10^6 volts had nothing whatever to do with an induction coil. On p. 163 we have the sentence: "The total value of the magnetic force within a circuit is known as the magnetic *flux* through the circuit." Now, what does the author mean by "the total value of the magnetic force within a circuit"? When touching on technical matters, the author does not scruple to make various erroneous statements with an airy assumption of superior knowledge. "Theoretically," we are told on p. 166, "every dynamo could be used as a motor and every motor as a dynamo. In practice, however, this power of reversibility is not used." Again, on p. 170, we read: "Owing to the self-

induction of each section of the armature, a certain amount of energy is used twice in each revolution to establish the current in it. *This energy is lost* so far as the external circuit or the effective output of the machine is concerned" (the italics are ours). This sentence shows that the author has never attempted to study the extremely complicated problem of commutation; it would, therefore, have been wiser to say nothing about it in an elementary text-book.

But we must stop, though we have by no means exhausted the various errors which mar the book. We have noted a few quite as glaring as those which have been adduced as samples. The book possesses some good features, notably the attempt to explain everything by considering the stresses in the medium; but it is so full of error that we feel bound to condemn it very strongly.

A. H.

Die Lehre vom Skelet des Menschen unter besonderer Berücksichtigung entwickelungsgeschichtlicher und vergleichend-anatomischer Gesichtspunkte und der Erfordernisse des anthropologischen Unterrichtes an höheren Lehranstalten. Bearbeitet von Dr. F. Frenkel. Pp. vi + 176. Mit 81 textfiguren. (Jena: Gustav Fischer, 1900.)

THE author has in course of publication, for use in the Gymnasia and Realschulen, a series of wall plates in which the anatomy of the human body is represented, and he has prepared the book now under consideration as a supplement to the plates which illustrate the skeleton. He devotes 176 pages to the description of the human skeleton, and includes an account of the joints which connect the bones with each other. He has adopted as the basis of his arrangement the plan followed by Gegenbaur in the "Lehrbuch der Anatomie der Menschen."

In the course of his description, Dr. Frenkel takes the opportunity of calling attention to the developmental changes which take place in the præ-ossific stage of the skeleton, as well as during the process of ossification itself, more especially in their bearing on the production of variations which, from time to time, come under the notice of anatomists. He contributes an interesting chapter on the variations in the number of vertebræ, more especially in the thoracic, lumbar and sacral regions, and explains the occasional occurrence in the dorsi-lumbar region of a vertebra which partakes partly of the characters of both these groups, and in the lumbosacral region of a vertebra which exhibits a transitional form between the lumbar and sacral series.

The opportunity is taken, from time to time, to point out the differences in arrangement and character between the human skeleton and that of the anthropoid apes, though in this respect many additional examples might readily have been given. It is, of course, impossible in a work of this kind to free the descriptions from technical terms and modes of expression; but the author, taking into consideration the class of readers for whom it has been written, has explained the meaning of the terms and, as far as practicable, has couched his descriptions in language to be readily apprehended.

De Paris aux Mines d'Or de l'Australie occidentale. By O. Chemin. Pp. 370 + 2 maps. (Paris: Gauthier-Villars, 1900.)

A DESCRIPTION of Western Australia from the mining point of view, illustrated with pictures characteristic of the scenes presented in a journey from Paris to Perth, and examined during short visits to other places in our premier gold-producing colony. The geography, population, government, mineral resources and gold fields of the colony are surveyed, and the condition and promise of individual mines commented upon. The author spent nearly a year in Westralia, and his book will direct the attention of his countrymen to an immense region, much of which is still little known.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Malaria and Mosquitoes.

INTERESTING letters by Mr. D. E. Hutchins and Mr. F. R. Mallet have recently appeared in NATURE, suggesting the possibility of there being some other route for infection in malaria besides that by the bite of Anopheles. Suggestions of this kind always appear to me to give rise to the questions, (*a*) whether the facts are really as stated? and (*b*) whether, if even this is the case, they cannot be explained by the mosquito theory? The notion that clearing jungle causes fever is very widely spread; but this does not prove that it is true. Granting that it is true, it may possibly be explained on the ground (*a*) that persons engaged in clearing jungle and laying out new plantations are not likely to be so well housed as those who live in established settlements; (*b*) that any hard labour encourages relapses of fever among coolies and others who have already been infected; and (*c*) that, as shown by Christophers and Stephens, jungle often contains large numbers of Anopheles. The frequent statements one sees, to the effect that malaria has prevailed largely when mosquitoes were few, are generally too vague to be of value, because it is not added whether the cases were relapses or fresh infections, or to what kind the "few" mosquitoes present belonged. When a man says that mosquitoes are numerous he generally refers to the genus Culex, which probably assert themselves more than do Anopheles. The idea that the water of the rivers of western India can cause fever when it is drunk is certainly opposed to my personal experience. In 1891 I went fishing with Mr. G. Tait, of Bangalore, in the River Bhawani, near Ootacamund. I remember that at the time I did not think that fever could be acquired by drinking such water, and I used daily to drink the unboiled water of this river (which flows amongst thick jungle). I remained quite free from fever, without taking quinine; but Mr. Tait was afterwards attacked. So far as I remember (but I am not sure), he had refused to drink Bhawani water; but I am not certain that his fever was malarial. Again, the idea that malaria is absent in the Nilgiri Hills round Ootacamund unless the soil is turned does not accord with my personal experiences. I acquired fever at Kalhutti (5000 feet above sea-level) in 1897, when I was investigating the disease in the Sigur Ghat. I thought at the time that I had acquired it in the plains below, but, in the light of our present knowledge, have little doubt that I became infected in the dak-bungalow at Kalhutti, where a succession of kitmutgars and their families had been taken ill. I noted particularly at the time that there was no freshly turned soil in the neighbourhood of the bungalow. Lastly, the case mentioned by Mr. D. E. Hutchins, namely that of a medically authenticated case of malaria being produced by fresh earth carried past a window in baskets by coolies, seems to me to be open to criticism. *Which* fact was medically authenticated—the fact that the patient suffered from malaria, or that his malaria was caused by the earth carried past in baskets? I can understand the first fact being certified by a doctor, but scarcely the second. How did the doctor prove that the fever was produced by the earth in the baskets? It seems to me that the only way in which he could have done so in a trustworthy and scientific manner would have been to infect a second person by having the baskets carried past a second time. I doubt whether such instances—and we see hundreds of them in the Press—will bear close examination. Those who cite cases of fever apparently due to freshly-turned earth, seem to forget that there are millions of people constantly engaged in digging without suffering from the disease more than others do.

Liverpool, February 25. R. ROSS.

Abundance of Peripatus in Jamaica.

MR. P. H. GOSSE in the "Naturalist's Sojourn in Jamaica" (p. 66) makes the first reference to the occurrence of Peripatus in Jamaica, having found in 1845 five or six specimens, near Bluefields, on the south-west coast of the island. Gosse regarded them as "rather allied to the Annelida than to the Mollusca." No further mention of the animal is made until it was rediscovered at Bath in 1892, nearly fifty years after, by a local naturalist, Mrs. Swainson. Seven Peripatus were sent to

the museum of the Institute of Jamaica, and later were briefly described by Messrs. Grabham and Cockerell in NATURE (1892, p. 514), when the specific term *Jamaicensis* was suggested. The year following over a dozen specimens were received by Dr. Grabham, also from Bath. The locality is in a most humid part of the eastern extremity of the island. Two or three examples have since been secured from widely separated spots, but the species has hitherto been regarded as one of much rarity, and as uncertain in its distribution. Various attempts made by different collectors to secure specimens have been unsuccessful.

Prof. E. L. Bouvier, who has lately been making a systematic study of the genus, recognises two species—*P. jamaicensis* and *P. juliformis* var. Gossei—among the Jamaica representatives, (cf. *Quart. Jour. Micr. Sci.*, vol. xliii. p. 750). Prof. Ray Lankester, on behalf of Prof. Bouvier, has recently communicated with the Institute of Jamaica asking for additional specimens. A general description of Peripatus was accordingly inserted in the local newspapers, and offers of reward were made with the object of encouraging the peasantry to search for the animal, but this was of no avail. A visit, since made by the writer, to Bath resulted in the securing of a number of examples. These were exhibited in the neighbourhood and a sum was offered for further specimens, with the result that before long numbers began to pour in and soon upwards of fifty were obtained. Dr. Grabham also secured a large supply. Afterwards more than eighty specimens were dispatched to the Museum, then another fifty were offered, and now that a local enthusiasm has been created it would seem that examples in plenty might be procured at any time. It is thus obvious that the animal is by no means so rare as has been supposed.

The creatures are found under stones and rotten wood, often buried for a short distance in the earth. Most are blackish brown or green, much lighter on the ventral surface; others are reddish black above and light flesh-coloured beneath; but many intermediate tints occur. A reddish-brown colour is extracted at first by alcohol, and the distinctive colours are soon lost. Specimens of all sizes were obtained, including individuals in which parturition took place during preservation. The length of the newly born was as much as 2 cm. J. E. DUERDEN.

Institute of Jamaica, Kingston, February 12.

Audibility of the Sound of Firing on February 1.

FROM the letters written to NATURE and to the *Standard* by correspondents who heard at very great distances the guns fired at Portsmouth on February 1, it seems to be the general impression that the firing was by volleys, if one may use a convenient but probably technically incorrect expression. This was not the case. It would be very desirable that the official order of firing should be published. If this is not done, there may be some interest in a note on the order as it appeared to me, watching from the sea-front near Southsea Castle.

The disposition of the fleet was roughly thus:

SOUTHSEA.

Channel Squadron.

Reserve Squadron. * *Flagship.*

Foreign ships.

OSBORNE.

The first gun of each round of firing seemed to me to be fired far down the line, from the flagship of the Reserve Squadron; but of this I cannot be sure. It was immediately succeeded by the gun from the *Majestic*, flagship of the Channel Squadron; and from this the firing ran down the double line, the intervals between the successive pairs of flashes being about half a second. It was impossible to see from Southsea whether the Reserve Squadron followed the lead of the Channel Squadron or of its own flagship. In the latter case, after the leading guns from the flagships there would have been four guns, in the former case two guns every half second, for a space of some seconds.

These details are from memory, and may require some correction. The important fact is that the guns were fired in quick succession, and not simultaneously.

The line of ships was about eight miles long, roughly east and west, and Southsea was about a mile north of the eastern end. But the roll of the guns lasted only about twenty seconds—that is to say, scarcely any sound reached us from the western division of the line, which was hidden from sight by a projecting point of land. It is not surprising, therefore, that nothing was heard at Chichester and other places comparatively near Portsmouth. ARTHUR R. HINKS.

Cambridge, February 26.

Protective Markings in Animals.

I ENCLOSE a photograph of my cat asleep, in which may be plainly seen the resemblance to open eyes, borne by the markings above the orbits. In the living cat this resemblance is so striking that my attention was first drawn to it by my fancying that he was sleeping with his eyes open.

I have noticed the same markings in other cats, but never quite so distinct. The advantages, to a non-domesticated animal, of such an arrangement are obvious, and I think it may interest some of your readers. Besides these marks over the eyes, I observe in a good many cats that the fur on the lower jaw is generally light and bounded by markings following the line of the mouth, thus giving a heightened effect when open, whilst when shut, during sleep, the cat has, at a distance, the appearance of having the mouth still open. CLARENCE WATERER.

Highfield, Northdown Avenue, Margate, February 26.

Snow Crystals.

A FALL of snow stars, similar to that described by Mr. Wm. Gee (p. 420), occurred near Sutton Coldfield about 1876, as near as I can remember. I was much struck by their beauty and the graceful way they fell to the earth. C. J. WOODWARD.

Municipal Technical School, Birmingham, March 2.

THE NEW STAR IN PERSEUS.[1]

DR. COPELAND was kind enough to inform me by telegram, on the afternoon of February 22, of the discovery by Dr. Anderson of a new star in the Milky Way in Perseus on the early morning of that day. It was stated that its position was R.A. 3h. 24m. 25s. and Declination $+43^{\circ} 34'$, its magnitude 2·7, and colour of a bluish-white. Later in the evening this information was corroborated by another telegram from the "Centralstelle" at Kiel.

Owing to cloudy weather, no photographs could be obtained at Kensington until the evening of the 25th. Momentary glimpses of the star on the evening of the 22nd, between the hours of 6 and 7.30 p.m., indicated that the Nova had considerably brightened since the time of its discovery, as it was estimated as a little brighter than a first magnitude star; no satisfactory observations of the spectrum could be made.

Another glimpse on the early morning (1.30 a.m.) of Monday (25th) showed that the star was still of about the first magnitude.

Prof. Pickering reports that the Nova was dimmer than an eleventh magnitude star on February 19. On the 23rd it was as bright as Capella.

The star, therefore, was then at least 10,000 times brighter than it was four days previously, and ranks as the brightest new star recorded since that which appeared in the year 1604.

Since the 25th the brightness has diminished slightly, and on the evening of the 27th was estimated between the first and second magnitude (1·7). If this reduction of brilliancy continues at the same rate, the new star will evidently be shorter lived than those to which it has most closely approximated in luminous intensity at the maximum, and less time will be available for studying the spectral changes which may be anticipated. I may state that Tycho's Nova (1572) was visible for nearly one and a half years, and Kepler's (1604) for about the same period.

It is interesting to note that the star was described by Dr. Anderson as being of a bluish-white colour at the

[1] Preliminary note. By Sir Norman Lockyer, K.C.B., F.R.S. Received and read before the Royal Society, February 28.

time of discovery. Since it has diminished in brightness this has changed, and on the night of February 27 a reddish tinge was observed.

Although the sky on Monday evening was by no means free from clouds, ten very satisfactory photographs were secured with the three instruments in regular use for stellar spectra. Edwards's isochromatic plates were used, as it was considered desirable to secure a record of the green part of the spectrum.

Although there has not been time for a complete discussion of these photographs, it may be stated that the spectrum contains numerous dark lines, several of which are associated with bright bands on the less refrangible side. Further, the spectrum, as a whole, greatly resembles that of Nova Aurigæ.

One of the chief features of the principal bright lines is their great width, amounting to 30 tenth-metres, and each is accompanied by a dark line of considerable breadth on its more refrangible side. A comparison spectrum of γ Orionis, photographed alongside that of the Nova on one of the plates, indicates that the middle portions of the bright lines are not far from their normal positions; those of the dark ones, however, are displaced by some 15 tenth-metres towards the violet, thus indicating a differential movement of something like 700 miles a second.

Movements more rapid and disturbances more violent than those observed in Nova Aurigæ are therefore indicated; both by the greater displacement of the dark lines relatively to those that are bright and the greater breadth of the bright and dark lines.

tested by inquiring whether other prominent enhanced lines of iron so strongly visible in the spectrum of α Cygni were present.

A comparison with the spectrum of this star photographed with the same instruments suggested that many lines between F and *h* in the Nova probably correspond with lines in α Cygni. Certainty could not be arrived at in consequence of the great breadth of the lines in the Nova.

Hence, as the Nova bore some resemblance to both Nova Aurigæ and α Cygni, a reference was suggested to the lines recorded in the spectrum of Nova Aurigæ which were observed when the light of that star was on the wane, and when the lines were thinned enough to be easily measurable. I may also add that these observations were made before the work on enhanced lines was undertaken.

The importance of this reference was strengthened by the consideration that with such a tremendous outburst we should expect the original invisible swarm to have been (very rapidly) advanced to a considerable condensation at the locus of impact, and therefore to resemble some "star" which had (slowly) arrived at a position pretty high up on the ascending temperature curve in the ordinary course of evolution on the meteoritic hypothesis.

A comparison of the bright lines recorded by Campbell[1] and Vogel[2] in the spectrum of Nova Aurigæ with the strongest lines of α Cygni—a very detailed record of the spectrum of which star has been recently compiled here—shows that there is a close agreement between the two sets of lines. These strong α Cygni lines are almost without exception the representatives of "enhanced" lines of some of the metals, chiefly Fe, Ti, Cr, Ni, Ca, Sr, and Sc. If we exclude the lines of hydrogen from those which were recorded in the spectrum of Nova Aurigæ, there remain forty-four lines for comparison. Thirty of these, or about 70 per cent., agree approximately in position with either strong isolated lines or groups of lines in the spectrum of α Cygni.

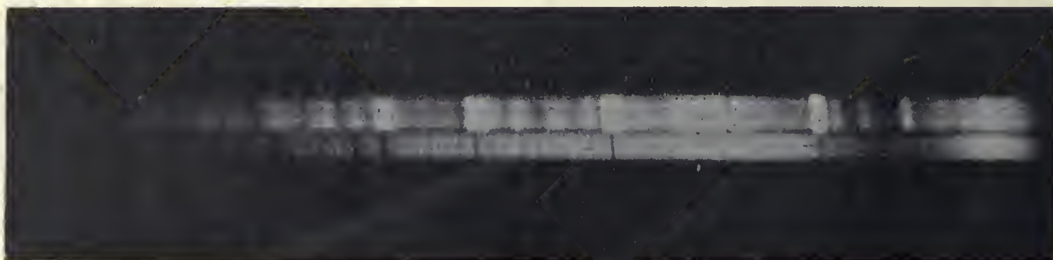

FIG. 1.—Spectrum of Nova and α Persei compared.

The comparison of spectra shows us that we are dealing with two swarms, one of which, the less dense, gives us broad bright lines and is almost at rest with reference to the line of sight; the denser swarm, indicated by the dark lines, is in most rapid movement in the line of sight towards the earth.

An interesting feature of the spectrum is the presence of fine dark lines down the middle of each of the bright lines of hydrogen and calcium; these are most probably reversals, and if this be so, they will be of great service for accurate determination of the wave-lengths of the other bright lines.

The dark hydrogen line Hγ, and perhaps Hβ and Hδ, are also possibly reversed.

Eye observations showed among the chief lines a group of four in the green; one probably Hβ, the others near λλ 492, 501 and 517; a bright line at or near D, and a brilliant red line probably corresponding to Hα. Each of these was accompanied by a dark broad line on its more refrangible side. Other lines of less brightness were observed both in the green and red.

It at first seemed probable that two of the bright lines in the green (λλ 492 and 501) might be due to asterium, while that in the orange was perhaps the helium line D_3. Subsequent investigation, however, suggested as an alternative origin that these lines might be the enhanced lines of iron at λ 4924·1 and 5018·6, which are very nearly in the same positions as the asterium lines. This view was

It may be assumed that, taking into consideration the broad nature of the Nova lines, if there be any genuine connection between them and the lines of α Cygni, any close groups of separately distinguishable lines in the latter spectrum would be thrown together in the Nova spectrum, and appear as broad bands. A good instance of this appears in Campbell's list. He records a band extending from λλ 4534 to 4501. In the spectrum of α Cygni there is a strong line at each of the positions given, and between them there occurs a strong quartet of lines. The former are well enhanced lines of titanium, and the latter of iron. It seems extremely likely, therefore, that the six lines thrown together produce the apparently continuous band observed by Campbell.

If the stage of α Cygni has really been reached, the following considerations come in:—

[1] *Ast.-Phys. Jour.*, vol. xi. p. 807, 1892.
[2] *Ast.-Phys. Jour.*, vol. xii. p. 912, 1893.

In the orderly condensation of swarms, according to the meteoritic hypothesis, the earlier stages are—

Ascending temperature.		
↑	Cygnian	Dark lines, corresponding chiefly with the enhanced lines of various metals.
	Polarian	Dark lines, comprising both arc and enhanced lines of various metals.
	Aldebarian	Dark lines, chiefly corresponding to those which appear in the arc spectra of various metals.
	Antarian	Mixed bright and dark flutings and dark lines. Bright hydrogen lines in those stars which are variable.
	Nebula	Bright lines.

In the case of new stars, after the maximum of luminosity has been reached, however high they ascend, short of the apex of the temperature curve, this order must be reversed, and hence we should expect to find the spectrum varying in accordance with the foregoing sequence, but in the reverse order.

In Nova Coronæ (1866), according to the observations of Sir William Huggins and Dr. Miller, the absorption spectrum was very similar to that of α Orionis, which is a star of the Antarian group, so that the temperature attained was relatively low; this, indeed, is demonstrated by the fact that at present it shines faintly as an Antarian star, and doubtless did so before the collision. The collision, therefore, probably did not take Nova Coronæ very much above its initial stage of temperature, and when the disturbance was over it simply reverted to its old conditions.

The spectrum of Nova Cygni (1876) was not photographed, and as special attention was given by most observers to the bright lines, there is no satisfactory record of the absorption spectrum.

This now appears as a nebula, and doubtless it was a nebula to begin with, as Nova Coronæ was a star to begin with.

In Nova Aurigæ (1892), as we have seen, the comparison with α Cygni indicates that the Cygnian (that is, a higher) stage was reached, and in the final stages its spectrum corresponded with that of the planetary nebulæ, that is, a stage lower than that reached by Nova Coronæ. The intermediate stages, however, were not observed, possibly because the star was never very brilliant, and partly because of the difficulty of observing closely grouped lines, such as occur in the Polarian and Aldebarian stages when they are rendered broad by such disturbances as those which were obviously present in the Nova.

The observed maximum magnitude in the case of a new star will evidently depend upon the distance and size of the colliding masses, as well as upon the temperature produced by the collision. It is not remarkable, therefore, that there is no apparent relation between the greatest brightness and the temperature indicated by the spectra. Nova Coronæ, with its relatively low temperature, shone for a time as a second magnitude star, while Nova Aurigæ, with a much higher temperature, scarcely surpassed a star of the fifth magnitude.

I now return to Nova Persei.

If the idea that in the present Nova the swarm which gives the dark line spectrum resembles α Cygni be confirmed, as its temperature is reduced we may expect it to pass successively through some or all of the stages of temperature represented by stars of the Polarian, Aldebarian and Antarian groups, enhanced lines being first replaced by arc lines and then by flutings. Whether it remains at one of these stages or undergoes a further backwardation into a nebula will be a point of the highest interest.

If, like Nova Aurigæ, the present Nova should end as a nebula, it will furnish a most convincing proof of the fundamental metallic nature of nebulæ.

In conclusion, I wish to express my thanks to Dr. W. J. S. Lockyer and Mr. F. E. Baxandall, of the Solar Physics Observatory, and to Mr. A. Fowler, of the Royal College of Science, who have greatly assisted me in preparing the present note, and who, with the addition of Mr. Butler, of the Solar Physics Observatory, secured the excellent set of photographs and eye observations on the night of the 25th, from which the new knowledge has been derived.

The preparation of the slides I owe to Mr. J. P. Wilkie.

Solar Physics Observatory, February 28.

RECENT SWISS GEOLOGY.

THE glaciers of the Alps have lost considerably in bulk during the last forty years. This began at rather different dates, for some were still advancing in 1860, while by 1870 the diminution was very marked. Since then there have been slight oscillations, but until lately loss, on the whole, has exceeded gain; now, perhaps, the tide has turned. The report on the Unter Grindelwald glacier, by Prof. A. Baltzer,[1] describes the changes this glacier has undergone during the abovenamed period, and the results of some special observations made between 1892 and 1897. It was unusually well suited for the purpose, for its changes had been very conspicuous, and they had been already more closely observed than in many other glaciers.

In 1858, as is shown in a photograph, the glacier descended to the level of the valley beneath Grindelwald, where the Weisse Lütschine, in the summer of that year, issued from an ice cave. By 1870 the glacier had retreated up the glen between the Eiger and the Mettenberg, exposing three great rocky steps, the existence of which, it may be remarked, is anything but a favourable testimony to the excavatory power of ice; and its thickness higher up had so much diminished that the writer looked down a cliff, fully sixty feet high, on to the surface very nearly at the place where he remembered stepping easily from the ice to the rock on his way from the Strahleck Pass. A photograph representing the state of the glacier in 1895, on which Prof. Baltzer has indicated its former extent, shows how great the change has been; the modern ice stream looking, by comparison, like a caterpillar crawling to hide its diminished head in a rocky gorge (Fig. 1). One remarkable effect of this shrinkage (as described by Mr. F. F. Tuckett in the *Alpine Journal*, vol. vi. p. 30), was to lay bare, in 1871, a quarry in a bed of mottled pale red and green marble, which had once been extensively worked, but for about a century had been completely hidden beneath the ice. By the retreat of the glacier large areas of ice-worn rock have been exposed, several of which are represented by photographs in Prof. Baltzer's memoir. From study of these he concludes that there are two forms of ice-erosion; one—the ordinary—smoothing or abrading of the rock surfaces; the other, a tearing and a splitting off of fragments in cases where the rock is much traversed by divisional planes. As he deems this to have been less generally recognised, he illustrates it by photographs. It is difficult without actual examination of the localities to form an opinion on this point. That the rock, chiefly from mechanical causes, is readily broken is beyond question; but, though the fragments thus formed would be more easily removed than from a solid mass, it is doubtful whether the ice plays more than a secondary part, so that the remark would be equally true of any other kind of erosion. Given an irregular surface, the friction of a body moving over it would tell upon the prominences; but probably more pieces fall away than are broken away.

[1] Vol. xxxiii., part 2, of the *Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft.*

The more minute observations on the changes in the volume of the glacier, which have been carried on from 1892 to 1897, prove constant variation, and suggest a connection with the prevalent temperatures. It is to be hoped these will be continued, for they will aid in the discovery of the causes to which the greater changes are due. The past history of the glacier shows a marked period of advance to have begun about the year 1600, reaching a maximum in 1620, after which it retreated. A strong advance set in at the beginning of the eighteenth century, and it attained a maximum just a hundred years after the former one, the ice then retiring. About 1743 it again advanced, but only for a short time, and this was followed by a marked retreat. But from 1770 to 1779 there was a great advance (which probably buried the marble quarry, and, so far as is known, hid it for nearly a century). But since then the oscillations have been considerable, for two periods of advance are recorded, one from 1814 to 1822, the other from 1840 to 1855, the effect of the latter remaining, as has been said, for four or five years. It is at present difficult to explain these singular changes of volume in the glaciers; very probably they are connected with both winter snowfall and summer temperature, but the former, as chiefly affecting the upper part of a glacier, may be some years before it produces an effect at the lower end, while that will be more immediately sensitive to summer warmth. Hence each glacier must be separately studied, as this one has been by Prof. Baltzer. The importance of the investigation is now generally recognised, and that not only in the Swiss Alps. In these, according to Dr. Richter (*Archiv. Genev.* vi. 1898, p. 22), of fifty-seven glaciers observed in 1897, fifty were still decreasing, five were stationary, and twelve were increasing, so that it will evidently be difficult to fix very precisely a date for the maximum and minimum of a whole region.

FIG. 1.—The Unter Grindelwald Glacier in 1895. The white lines show the extent of the glacier in 1858.

Other memoirs recently issued by the Swiss Society of Natural Science deal with various subjects. Vol. xxxvi. (1899), Part i. contains two memoirs. One, by Dr. M. Standfuss, "Experimentelle Zoologische Studien mit Lepidopteren," illustrated by five plates, is an investigation of the effect of temperature, either continuously higher or lower than the average, but within the possibilities of nature, upon the imago of lepidoptera, the pupa of which have been thus treated. The cold, speaking generally, seems to reduce the size of the imago and makes it paler in colour, the heat having the contrary effect. The second memoir, "Monographie des Genus Elaphoglossum," by Dr. H. Christ, illustrated by four plates, is an elaborate botanical study.

Vol. xxxvi. (1900), Part ii. also contains two memoirs. One is by Prof. Ed. Fischer, "Untersuchungen zur vergleichenden Entwicklungsgeschichte und Systematik der Phalloideen," illustrated by six plates and four cuts in the text, in which the relationships of the several forms are elaborately worked out. The other, by Dr. Emil Hugi, "Die Klippenregion von Giswyl," with six plates of sections and scenery, gives a full and careful description of one of these remarkable isolated rock masses, which are so frequent on the northern margin of the Alps and Carpathians. Sections representing the actual stratigraphy of the district are followed by others showing how this has been produced; namely, by an overfolding followed by denudation, more especially affecting one of its limbs, and that by a second folding in this portion which has resulted in an overthrust.

Dr. Zschokke's memoir on "Die Tierwelt der Hochgebirgsseen," vol. xxxvii. (1900), pp. 400, with three maps and eight plates, gives much information on the physiography of the lakes of the Higher Alps, as well as a full account of their fauna. Here we find local reproductions of almost Arctic conditions in the midst of a temperate zone, and the fauna, in many respects, may be representative of glacial times. During these the lakes would be mostly, if not wholly, occupied with ice, but as it gave place to water this would be peopled by organisms, partly transferred by birds, partly making their way up stream from lower levels. Of this fauna Dr. Zschokke gives lists and descriptions. It is far from inconsiderable, having representatives of the majority of the invertebrata from the rhizopods upwards, with fishes and amphibians as vertebrates. Of the former, thirteen species are mentioned as occurring in lakes over 1400 m. above sea-level, *Salmo lacustris* and *S. salvelinus* having the highest range, for they occur in the Finailsee, 2690 m. Of amphibians six are enumerated, of which *Rana fusca* reaches the greatest elevation, being found up to 2400 m.

Dr. Zschokke's memoir is full of most valuable information and will be for long consulted by all interested in the distribution of life in the Alps.

Dr. Lorenz's monograph[1] deals with a rather isolated range of no great elevation, the culminating point, the Fläscherspitz, being only 1137 m. above sea-level, but it is one of great interest, which has attracted the attention of Swiss geologists for quite half a century because of its palæontology (the strata range from the Inferior Oolite upwards) and its tectonic structure. On the former ground it is chiefly remarkable, because here the fauna of the "Dogger" changes from its western to its eastern facies; on the latter because its geological structure is extremely complicated, and the relation which it bears to the neighbouring parts of the chain is not easily determined. The range has a general trend from north-west to south-east, the smaller part being in the Principality of Liechtenstein and the rest in Canton Graubunden. A study of the tectonic structure shows the range to consist of Jurassic and Neocomian beds, its south-eastern portion being formed of a much-broken overfold pointing towards the north-west, followed in this direction by a synclinal, which includes a minor overfold and has its axial plane roughly parallel to the former one. Dr. Lorenz connects these crust wrinklings with the famous "Glarner doppel-falte," which, however, he would prefer to call the "Glarner Bogen." The structure, in his opinion, is a result of the sinking (senkung) of the Oberland massif. He gives a succession of sections along the line of curve to prove the relationship, but we should substitute "upheaval" for "sinking" in explaining the structure. The crystalline core indicates the region where the oldest rocks have been raised to the greatest elevation, and have thus produced, by their resistance to further movement, the wrinkling, overfolding and overthrusting of the peripheral sedimentary masses. He thinks also that there have been two sets of movements, which indeed is corroborated by other regions of the Alps.

GEORGE FRANCIS FITZGERALD.

THOSE who knew the University of Dublin twenty years ago will remember that the idol of the undergraduates and the hope of the older men was George Francis FitzGerald. He was of high intellectual lineage on both sides: his father was the most distinguished prelate in the Irish Protestant Church, and his uncles are men of large and original scientific achievement. His early education was conducted at home, in company with his two brothers, one (now professor of engineering at Belfast), a year older than himself, the other younger. He was good at physical science and all subjects requiring close observation, from his earliest years; and the ambition to become a master was soon aroused. The mathematical and physical tendency seems to have come mainly from his mother's side, his strong metaphysical bent from both sides of the family. In his student career he attained all the distinctions that lay in his path with an ease, and wore them with a grace, that endeared him to his rivals and contemporaries. On taking his first degree in 1871 he settled down, at twenty years of age, after the manner of the pick of the Dublin men, to a wide and independent course of reading with a view to a Fellowship. At that time vacancies were of very rare occurrence; so that it was not until 1877, on his second time of trying, that he attained the position of a Fellow of Trinity College. The examination in mathematical and physical science included papers on selected portions of the works of the great mathematical physicists; to a mind of the calibre of FitzGerald's, the early and intimate acquaintance which was thus promoted with the classical writings of Lagrange and Laplace, of Hamilton and MacCullagh, with their modes of thought as well as the results that they won, must have formed the best possible foundation for a scientific career. A training which aims only at sound knowledge and established results may find a shorter path in the study of the latest text-books of the day; but if a man is to be a true leader he must be interested even more in the philosophy than in the facts of his science. It must have been of rare value to a maturing mind of keen temper to observe closely at first hand the lines of attack of the great masters of the past age on problems which were crystallising into knowledge. Acquaintance with the present state of science, however detailed and exact, assumes its full value as an instrument of progress only when it is accompanied by appreciation of the difficulties that had to be circumvented in order to reach it, and by observation of the way in which complete logical precision may have to be attained at the expense of temporary limitation. The subjects that were grouped around physical optics were approached in Dublin, in those days, through the study of MacCullagh's optical memoirs; these writings were based on a remarkable combination of keen analysis of the facts and direct application of the generalised dynamical methods of Lagrange, thus presenting all that interest of nascent scientific discovery which the same topics still retain in their wider connection with the general problem of the æther. Whatever may be the defects of MacCullagh's analysis, it had the saving merit that it put forward no claim to finality; its critical comparison and contrast with those of Cauchy and Neumann and Green, and the difficulties which its procedure suggested from a restricted dynamical point of view, were the very things with which a mathematical analyst might be impatient, but over which a mind constituted like FitzGerald's would eagerly brood. When the great Treatise of Maxwell, which threw a flood of light on these fundamental problems from an altogether novel source, came into hands thus prepared for its appreciation, it is not surprising that a main scientific interest became established for life.

After obtaining his Fellowship, FitzGerald became attached to the department of experimental physics, and conducted or influenced much of the teaching in physical science, in addition to carrying on the work of a College tutor. In the latter capacity he was eminently successful. It was an object of ambition to gain admission to his side, which was always full a long time in advance. He had considerable athletic prowess, which was kept up for many years; and his services were in great request for presiding over and administering the athletic organisations of the College. He gave up tutorial work in 1881 on succeeding to the chair of experimental philosophy, which he held for the rest of his life. He became a Fellow of the Royal Society in 1883, and in 1899 received the award of one of its Royal Medals.

In those early years there were three main centres of development of the new departure in electrical theory which has since revolutionised the whole domain of physical science. Maxwell's own presence as a professor had guided the trend of physical thought at Cambridge predominantly into that direction which it has since largely retained; in Berlin, Helmholtz was devoting his great powers and turning the attention of his pupils to the discussion and elucidation of the subject; while in Dublin its study and investigation became vital under FitzGerald's lead and influence. His chief formal memoir, "On the Electromagnetic Theory of the Reflexion and Refraction of Light," was presented to the Royal Society at the end of the year 1878; it retains a place among the classical writings of modern physics. In the years from 1880 to 1885 he contributed to the

[1] "Monographie der Fläscherberges." By Dr. Th. Lorenz. Beiträge zur Geologischen Karte der Schweiz, Neue Folge, X Lieferung, with geological map, 4 plates of sections, and 13 other illustrations. Pp. 64.

publications of the Royal Dublin Society, of which he was secretary for about ten years, many short condensed papers, on the optical and electric influence of the Earth's motion, on the amount of the electric radiation from an alternating current, on a model illustrating the properties of the æther, all of which went straight without superfluous analysis to the core of the matter on hand, and eminently merit Mr. Heaviside's description (*infra*) as "not large in bulk, but very choice and original." At the present time, after so much progress has been made in the abstruse but fundamental topics with which they deal, these pioneering papers, like Maxwell's Treatise on which they are based, still repay careful study. It is much to be desired that they may soon be republished in more accessible form, along with their author's other scattered writings.

As years passed, the calls on his time became more numerous, in the tender care of his family, in the discharge of public duties, and in response to requests for advice from an ever-widening circle of devoted scientific friends; so that his opportunities for continuous study almost disappeared. But he always managed to keep wonderfully abreast of scientific progress in a very wide range of knowledge, and spent most of his spare time in deeply pondering over its meaning. The scientific public of this country was placed very early in touch with Hertz's magnificent and decisive verification of electrodynamic theory, through the attention commanded by FitzGerald's brilliant exposition in his British Association address of 1888. It was fitting that this should come from him; for, as Lord Kelvin has recalled, he had five years before pointed out to the British Association the possibilities of the very plan of obtaining electric radiation of manageable wavelength which in Hertz's hands has led to success. His own activity became more and more absorbed in the administration of the College laboratory, rendered more arduous by limited funds and distance from other scientific centres, and in the promotion of the practical and technical side of physical science. Yet he still followed very closely the progress of abstract mathematical physics; hardly any one could be named who had thought more deeply, or whose knowledge was more available and many-sided, more entirely free from all prepossession or prejudice. At the meeting of the British Association last September he was, as usual, present, and was of course one of the prominent figures; the writer, speaking from full knowledge, can testify that the proceedings of the physical section were interesting and successful from one cause beyond all others—the assiduity with which he devoted himself to attendance, and the unceasing flow of valuable suggestion and appreciative criticism which he contributed. His stores of knowledge were ripening and maturing in fibre year by year; his memory was unfailing, and each new fact or phenomenon seemed to find its place at once in the setting to which it belonged. Whatever views were presented to him, however much they jarred with his own ideas, were certain to receive patient and careful consideration. There was nobody who did more to encourage younger men and to bring out what was best in them; the time which he was accustomed to devote without stint to the elucidation and improvement of the work of others sadly diminished the opportunities for work more especially his own. His advice and judgment were valued over the whole range of physical science, not less in foreign lands than at home, notwithstanding that he published so little. When a physicist or physical chemist came to a puzzle or paradox, or was in doubt between various plans of procedure, it seems to have come to be almost the natural course to write to FitzGerald. A letter of inquiry or criticism always elicited a prompt reply, entirely devoid of pretension to magisterial authority, but certain to bring out new aspects of the subject and exhibit its connections with other problems. He was constantly acting as referee of scientific papers for the Royal Society and other bodies, and was accustomed to interest himself in them as if they were his own work.

He frequently acceded to requests to serve as examiner on physics in other Universities, notwithstanding the serious drafts on his time and energy that were involved; his connection with the University of London in that capacity has been almost uninterrupted since 1888. He became one of the Commissioners of National Education in Ireland in 1898, and immediately threw himself into the task of reconstituting primary education on more practical lines, undertaking a tour through the United States in the autumn of that year in order to study American methods. Last year he was appointed a member of the Irish Board of Intermediate Education, and much was expected from his assistance in working out the difficult problems that engage their attention. In his own University he was always in the forefront of progress, and often wished to move faster than an ancient institution is usually inclined to allow.

In a private letter, in response to a hurried intimation of FitzGerald's death, Mr. O. Heaviside writes as follows:—"I only saw him twice knowingly, once for two hours, and then again for six hours, after a long interval; yet we had a good deal of correspondence at one time, and I seemed to have quite an affection for him. A mutual understanding had something to do with that. You know that in the pre-Hertzian days he had done a good deal of work, not large in bulk but very choice and original, in relation to the possibilities of Maxwell's theory, then considerably undeveloped and little understood; and his way of looking at things was more like my own than anybody's. Well, he found that I had done a lot of work in the same line, and he was most generous in recognising and emphasising it. Too generous, of course. You remember that review of my 'Electrical Papers' that he wrote? No one knew better than myself how to allow for his temperament and desire to help me. He used to write to me a good deal about electromagnetic problems, and I laid down the law to him like—like myself, in fact. He took it all very pleasantly. But I knew all the while that he had a wider field than myself, and no time to specialise much. He had, undoubtedly, the quickest and most original brain of anybody. That was a great distinction; but it was, I think, a misfortune as regards his scientific fame. He saw too many openings. His brain was too fertile and inventive. I think it would have been better for him if he had been a little stupid—I mean not so quick and versatile, but more plodding. He would have been better appreciated, save by a few."

Prof. W. Ramsay writes on the day following his return from India, when the first news came to him:—

"I understand that it has been thought right for some of FitzGerald's friends to contribute each a short notice of him as a tribute to his memory. The blow is so recent and the feeling of personal loss so acute that this is a difficult task. But to me, as to many others, FitzGerald was the truest of true friends; always interested, always sympathetic, always encouraging, whether the matter discussed was a personal one, or one connected with science or with education. And yet I doubt if it was these qualities alone which made his presence so attractive and so inspiring. I think it was the feeling that one was able to converse on equal terms with a man who was so much above the level of one's self, not merely in intellectual qualities of mind, but in every respect. I know that FitzGerald would have been the last to acknowledge this, for he had no trace of intellectual pride; he never put himself forward, and had no desire for fame; he was content to do his duty. And he took this to be the task of helping others to do theirs. This was happily expressed by the President of the Royal Society in awarding him one of the Royal Medals, when he alluded to the great influence exercised on the progress of science, due to FitzGerald's placing his services

unreservedly at the disposal of every one anxious to carry on physical or chemical research.

"I do not think that FitzGerald ever harboured an angry or uncharitable thought about any one, nor have I ever known any one who, knowing him, did not regard him with the greatest love and respect; for he was known to be absolutely true to himself, and therefore to his fellow men. Although he held strong views on many points and could defend them with vehemence, his argument was never a personal one; and it was obvious that he was actuated solely by a love of truth, and that his only object was to defend what he thought to be right. Moreover, what FitzGerald thought to be right was pretty sure to turn out to be right in the long run. May I suggest as the reason why FitzGerald was so universally beloved, that he was a Christian in the truest sense of the word, and that he followed very closely the footsteps of his Master?"

In a letter from Prof. Tilden to the *Times* of February 27, in which, as Dean of the Faculty of Science of the University of London, he "places on record their high appreciation of his brilliant qualities as a man, as a teacher, as an investigator, as a leader of scientific thought," he goes on to speak on his own behalf of FitzGerald's modesty and extreme unselfishness, of the clarification and enlightenment which many a scientific man has owed to his inspiring conversation, of the "most memorable discourse" which he delivered to the Chemical Society in 1896 as the Helmholtz lecture. The key of deep personal loss is struck in a touching and eloquent tribute communicated to the *Electrician* by Dr. O. Lodge, and in a shorter notice in the *Times* and the *Philosophical Magazine*, coming from one who writes with authority on the industrial applications of science.

Prof. Perry, speaking as President of the Institution of Electrical Engineers, records that "in all engineering questions he had not only the laboratory experimenter's point of view, but also that of the practical engineer. His was a mind that saw the bearing of all scientific knowledge on any practical problem. I have no hesitation in saying that in Prof. FitzGerald our profession has lost one of its greatest, most beneficent forces." In proposing a vote of condolence, Prof. Ayrton spoke to the same effect.

The pride and affection which he inspired in his own College is revealed in a masterly appreciation contributed to the *Athenaeum* by one of his colleagues on the literary side. "His appearance was not unworthy of his fame. More striking he was than handsome; but his ample grey locks and beard, his furrowed brow, his penetrating eyes, reminded one of the bust of some Greek philosopher, which we cannot look upon without that instinctive feeling of respect which intellect and character command among civilised men."

For some years he had been in precarious health. He was subject to recurring attacks of digestive trouble; but the buoyancy with which he threw them off, and the unabated zeal with which he returned to his scientific pursuits in the intervals of health, concealed the real gravity of the situation. News of a sudden crisis was received in London and Cambridge with universal feelings of deep concern. He has now passed (on February 21) from the scene of an active and most beneficent career, in the fiftieth year of his age. His memory will not die. It will be carried on by a school of experimental physics, including the names of Joly and Preston and Trouton and W. E. Wilson, which he was mainly instrumental in creating; while in a wider sphere men such as Heaviside and Lodge and Ramsay and Perry have been proud to testify to their indebtedness and to claim him as their master. His scientific place will be henceforth alongside Rowan Hamilton and MacCullagh and Humphrey Lloyd, and the other famous men who have secured for the Dublin school so prominent a position in the edifice of modern physical science. In the higher domain of heart and conduct the recollection of his qualities will be an abiding treasure to all who knew him.

J. L.

NOTES.

WE learn from the Political Notes in the *Times* that the recent dismissals at Coopers Hill College were discussed on Monday at a meeting held in one of the committee-rooms of the House of Commons. The meeting was convened by Sir W. Anson, Sir Michael Foster, Mr. Milward, and Mr. C. P. Trevelyan; and the attendance included Mr. Haldane, Mr. Emmott, Mr. C. Douglas, Mr. Yoxall, Mr. Palmer, Mr. Spear, Mr. E. Gray, Mr. Lecky, Mr. Cohen, Mr. J. G. Talbot, Mr. Bartley, Mr. Norman and Mr. Howard. Apologies for inability to be present were received from Sir R. Jebb, Sir J. Batty-Tuke, Mr. J. A. Campbell, Sir L. McIver and Mr. Leigh-Bennett. This list, it will be seen, includes not only members of all the British parties, but the representatives of all the Universities. It was decided to request another interview with Lord George Hamilton, in order to press upon him the necessity for an inquiry into the whole circumstances. Failing success in this endeavour the matter will be brought forward in the House at the earliest possible opportunity.

IN the House of Commons on Tuesday, Lord George Hamilton said, in reply to a question by Mr. O'Mara:—Colonel Ottley's suggestions for the rearrangement of the course of study at Coopers Hill are dated June 13, 1900, and the report of the board upon them is dated the 24th of the same month. The visitors who signed the report are, with scarcely an exception, experts of the highest authority upon the technical questions submitted to them, and thay are selected in order that they may advise as experts.—Mr. O'Mara asked whether the conclusions were come to by the committee at a single sitting. Lord G. Hamilton said that the committee had the memoranda some time before them. The report was a long and exhaustive one, but he could not say whether its consideration only occupied one sitting. Mr. O'Mara: "Was not the meeting to consider the report called for the 24th, and did not the committee report the same day?" No reply was given. In answer to a further question by Mr. O'Mara, Lord G. Hamilton said:—Colonel Ottley was informed when he became president that the existing system of instruction was not considered to be satisfactory and required remodelling. Colonel Ottley has an unbroken experience of twenty-five years' service in India in almost every department of civil engineering, and the special knowledge he thus obtained of the training and capacity of the young engineers working under him from Coopers Hill pre-eminently qualified him to advise as to the special technical training required for the Public Works Department in India.—Mr. O'Mara asked whether he was to understand that the code of regulations, which provided that the president should be assisted by the teachers in regulating the course of studies, was not carried out by the present president. Lord G. Hamilton understood that Colonel Ottley had been in frequent communication with the teachers.

A SMALL zoological expedition is just starting for the Malay Peninsula. It consists of Mr. N. Annandale, who was a member of the "Skeat" expedition to the Siamese Malay States in 1899, and Mr. H. C. Robinson, hon. research assistant in the Zoological Department of University College, Liverpool. They intend to settle for a year in the native State of Jalor, near the east coast of Lower Siam, and to explore the neighbourhood of Patani and Biseret. Collections will be made in all branches of natural history, while one of the special objects of the expedition is the study of the pre-Malayan tribes.

of Negrito stock who inhabit the centre of the peninsula. A thorough investigation will also be made of the fauna—both living and extinct—of certain very large limestone caves which are found in the district, and are said to extend for great distances underground. The birds of the district will also be studied, and observations made on mimicry and allied phenomena. The ethnographical work ought to be interesting, since Jalor is on the borderland in which the Siamese and Malay races meet. Mr. Robinson is supplied with dredges and tow-nets for the investigation of the marine fauna, and he proposes, by the method of pumping sea-water through fine silk nets, to make a collection of the surface plankton of the Red Sea and Indian Ocean on the voyage out.

COMMANDER R. F. SCOTT, R.N., in naval charge of the British Antarctic Expedition, has stated to a representative of Reuter's Agency that the preparations for the British Antarctic Expedition are now practically complete. The *Discovery*, the expedition's ship, will be launched on March 23, and, after she has been handed over by the contractors, will come round to London, where her equipment and provisions will be put aboard. The *Discovery* has been built on whaler lines, only with greatly increased strength to withstand ice pressure. She is 171 feet long, and 34½ feet beam, and has 1500 tons displacement. She will have auxiliary steam, and is fitted with engines of the latest type. In her construction the lines of the *Fram*, though carefully studied, have not been adopted, as Nansen's ship would have been ill-adapted for the heavy seas the *Discovery* will have to encounter. The expedition will leave London in July or August, and will proceed to Melbourne, reaching there in November. The actual work of the expedition will then begin. The naval staff, in addition to Commander Scott, consists of Lieut. A. R. Armitage, Lieut. Charles Royds, and two other officers yet to be appointed. The scientific direction will be under Prof. Gregory, of Melbourne University, assisted by Mr. Hodgson (biologist), and Mr. Shackleton (physicist). The medical staff will consist of Dr. Koettlitz and Mr. Wilson.

HIS MAJESTY THE KING has signified to the president and council of the Marine Biological Association his pleasure in becoming the patron of the Association.

A MEETING of the International Association of Academies will be opened at Paris on April 16. Several delegates of the Royal Society will be present.

THE Bessemer gold medal of the Iron and Steel Institute for 1901 has been awarded to Mr. J. E. Stead, of Middlesbrough, in recognition of the value of his researches on iron and steel. The presentation will take place at the annual general meeting on May 8. Owing to the death of the Queen, the annual dinner will not be held. The autumn meeting will be held in Glasgow, simultaneously with the International Engineering Congress on September 3 to 6.

THE Naples Academy of Mathematical and Physical Sciences has awarded the mathematical prize of 1000 lire for 1899 to Dr. G. Torelli, professor at Palermo. The subject fixed was the totality of prime numbers. The theme for the next award is the theory of invariants of the ternary biquadratic considered preferably in relation to the conditions for splitting into lower forms. The essays may be written in Italian, French or Latin, and must be sent in, designated by a motto, before March 31, 1902.

THE success of the banquet recently given to Prof. Marey by the Scientia Club of Paris, has induced a number of his colleagues, friends and students to form themselves into a committee having for its object the presentation to him of a medal in token of their esteem. There are probably others who would like to show their appreciation of Prof. Marey's work by subscribing to the fund being raised for the preparation of the medal to be struck in his honour. Subscriptions should be sent to M. P. Masson, 120, Boulevard Saint-Germain, Paris.

THE Easter cruise to the Isles of Greece, organised by Dr. Lunn and Mr. Perowne for schoolmasters only, is, we understand, already full. As the idea is evidently an attractive one, another cruise to the principal cities of Spain has been arranged for the Easter vacation, under the direction of Mr. E. H. Blakeney, of the Sandwich Grammar School. The party will leave London on the Wednesday morning before Easter, spending Good Friday at Burgos, Easter Day at Madrid, and visiting Cordova and Seville. Those who then wish to return to England can do so, and will get into the direct express at Seville. A party, however, will be formed to visit Granada, returning from Granada to Seville; and a further section will visit Toledo, those who have not time to take in both cities going straight back, after the visit to Granada, from Seville to London. During the cruise Mr. Blakeney will deliver a couple of lectures on (1) "The Moorish Domination in Spain, (2) "Some Cities and Cathedrals of Spain." We should like to see similar cruises organised for men of science, as has already been done in connection with the *Revue générale des Sciences* (see p. 381).

THE fifth triennial International Congress of Physiologists will be held at Turin, September 17 to 23 of this year. The Institute of Physiology of the University, under direction of Prof. Angelo Mosso, will be placed at the disposal of the Congress. The membership of the Congress is open to (1) representatives of physiological and similar purely scientific societies, for example, the Physiological Society, England; the American Physiological Society; Société de Biologie, Paris; Physiologische Gesellschaft, Berlin. (2) Persons proposed by the National Committee of their own country. In connection with the Congress an exhibition of apparatus will be open from September 14 to 23. To it the Marine Biology station at Naples will contribute a collection of marine forms of animal life useful for comparative physiology. In addition to the General Secretaries, for the work of preparation toward the the fifth Congress, Dr. F. S. Lee, secretary of the American Physiological Society, will discharge secretarial duties in the United States. Those desirous of attending the Congress or contributing to the exhibition should communicate with Prof. Sherrington, General Secretary for the English-speaking countries, Thompson Yates Laboratories, the University College, Liverpool.

THE *British Medical Journal* announces that Dr. Gerhard Armauer Hansen, the discoverer of the lepra bacillus, will celebrate his sixtieth birthday on July 29. His friends and admirers, both in and out of the medical profession of Norway, have decided on that occasion to erect a marble bust of him in the Lungegaard Hospital, Bergen, where he discovered the bacillus. A committee of Norwegians has been appointed to solicit subscriptions from Dr. Hansen's friends in the Scandinavian countries, and Prof. Lassar, of Berlin, has undertaken to collect subscriptions for the purpose on the continent.

A CONFERENCE was held at Liverpool on Monday between representatives of the Liverpool and Manchester Chambers of Commerce and the Liverpool School of Tropical Medicine, with reference to the unhealthy conditions of the towns on the West African coast. Mr. A. L. Jones, who presided, said that the West African merchants and shipowners would do well in their own interest, as well as in the interests of humanity, to take advantage of anything that would tend to improve the condi-

tions of life of the people they might send to the tropics to push their commerce. Hitherto Liverpool merchants had had more to do with the development of trade in that part of the world than perhaps any other merchants. That trade promised to be of great magnitude, and no amount of time and money could be devoted to a better purpose than to improve the conditions of life on the West Coast. They in Liverpool had done something by establishing the School of Tropical Medicine, which had inspired the whole world with a sense of its responsibility. Prof. Boyce suggested that the chambers should send out an expedition of experienced medical men and a young engineer to draw up definite schemes for drainage and water supply. Mr. A. Hutton, chairman of the African section of the Manchester Chamber of Commerce, declared that the sanitary condition of some West African coast towns was disgraceful. If they decided that a commission should be sent out they had better send it themselves, and not wait for the Government. Major Ross agreed with the suggestion to send out another commission. Municipal regulations, he said, were absolutely ignored on the coast, and the Government should be urged to take an interest in the matter. It was unanimously decided to ask Mr. Chamberlain to receive a deputation to consult with him on the questions of sewage disposal, water supply, malaria, and dysentery in West Africa.

A REGRETTABLE state of affairs with regard to the preparation of a Lexicon of the native language of New Zealand, is described in an obituary notice of the Rev. W. Colenso, F.R.S., just published in the "Year Book of the Royal Society." We trust that the following plain statement of the position of the work will lead to something being done to ensure its completion. "In 1861 Mr. Colenso entered Parliament as representative of Napier, when he moved and carried a resolution that the time had come for the State to make an organised attempt to rescue the dying language of New Zealand from oblivion. Being at the time unable to undertake such a work himself, he offered to present the Government with his whole collection of materials for it. In 1865 the Government took up the subject, and in 1866 Mr. Colenso, then being more at liberty, was successfully urged, as the one man in New Zealand thoroughly qualified, to take up the work. Seven years was fixed for its completion, the remuneration to be 300*l.* per annum. Before half that period had expired, another Ministry, with other views of the value of a Lexicon, had supervened, by whom its author was informed that, half the time allowed for the completion of the work having expired, one-half of the work itself should have been in the press. On the unreasonableness of this view in the case of a work requiring innumerable cross references being represented, a committee of qualified persons was appointed to examine and report on the progress made. The report was to the effect that the author had advanced further in his work than was due up to the time employed, that thousands of pages had been written from the first word to the last, and that seven years was too short a time for the completion of a work of such magnitude. The report was withheld from Parliament, funds for proceeding with the Lexicon were refused, and the unfinished materials were thrown upon the author's hands, one finger of which was permanently disabled by writer's cramp, due to his labours on the Lexicon. A sample portion was, however, demanded to be laid before the House, and letter A produced, but this was "lost," and not discovered till eighteen years afterwards in a departmental pigeon-hole. It was then printed and distributed by Government, partly at its author's expense, in the year preceding his death. Its appearance, dedicated to his old friend Sir George Grey, has been followed by urgent representations to the Colonial Government that the whole materials, which are bequeathed to the State, should be entrusted to a competent editor for publication."

WE have received from Dr. Hergesell, president of the International Aëronautical Committee, a preliminary account of the results of the ascents on February 7. A manned balloon from Cracow attained a height of 4000 metres and recorded a minimum temperature of $-11°$ F. One of the unmanned balloons from Berlin reached an altitude of 9490 metres and registered a temperature of $-67°$; a manned balloon was also sent up. Two unmanned balloons ascended from Trappes (near Paris); one of them reached 12,700 metres and recorded a temperature of $-67°$. From Strassburg two ascents were made; a paper balloon rose to 8000 metres and a temperature of $-49°$ was registered. Ascents were also made from Vienna and Bath. M. Teisserenc de Bort has promised to send one of his coadjutors to Moscow with the view of organising unmanned balloon ascents from that place.

An interesting description of the Lake Superior mining district is contributed to the *Century Magazine* by Mr. W. Fawcett. The yearly output of ore in the district amounts to twenty million tons, which is more than double the product of any other iron-mining region in the world during any single year in history. None of the mines in the Lake Superior country are more than a hundred miles from the lake, but the hills on the summits of which the deposits are found are, in some cases, more than a quarter of a mile above the level of the lake. Several methods of mining are in vogue in the four ranges of the iron region. On the Mesabi range the ore is taken out by means of steam-shovels. The Mesabi ore is found in great masses on the slopes of hills, and virtually the only task before the miner is to scoop it up and load it into the trucks standing on the siding, which are run into the mine just as trucks are often backed into a stone-quarry. Out of some of these immense holes in the ground more than a million tons of ore are taken every year, and it is all dipped up by steam-shovels. Improved systems of mine haulage are also used. Electric or compressed-air motors draw trains, each composed of about twenty trucks, from the mouth of the shaft to the point underground where the ore is being dug out, and machine-drills, driven by compressed air, have displaced the hammer and drill of the pioneer miner.

AT the Institution of Civil Engineers on Tuesday, February 26, Messrs. W. H. Stanger and B. Blount described the rotatory process of manufacturing cement. By this process it is possible to approach the theoretical ratio of acids to bases, and to obtain a cement which is stronger and sounder than the best cements commercially prepared by discontinuous processes. The largest and most complete installation of rotatory kilns is that at the works of the Atlas Cement Company of Northampton, Pennsylvania. The output of this works is between 8000 and 9000 tons per week, *i.e.* about four times the amount of most large European works, and the whole quantity is obtained from rotatory kilns. The raw materials used by the Atlas Company are a calcareous shale and a limestone. These are crushed, dried, finely powdered and fed mechanically into rotatory kilns. The kilns are steel cylinders 60 feet by 6 feet 6 inches, set on a slight incline and capable of being rotated by suitable gearing. The fuel is powdered coal driven in by a blast of air through an injector burner at the lower end of the kiln. An intensely hot flame, readily controllable, is thus produced, and heats the raw materials introduced at the upper end of the kiln, and caused to travel downwards in a direction opposite to that of the blast. The materials are thus heated systematically, and at the lower end of the kiln near the burner become converted into clinker. This falls into a rotating cylinder lined with firebrick, through which passes a current of air serving to feed the coal-dust flame. A great part of the heat of the clinker is thus regenerated. The clinker is then roughly crushed between rolls which work under

a spray of water and passes through a final rotating cooler into trucks, by which it is conveyed to stock-boxes over the grinding plant. From the crushing of the raw materials to the storing of the finished cement, no hand labour was employed, all conveyance, distribution and transmission being done mechanically.

IN the *Journal* of the Royal Statistical Society, lxiii. part iv., Mr. Thomas Welton discusses the distribution of population in England and Wales and its progress from 1801 to 1891. In 1801 the author finds (1) that urban populations, including most small towns, amounted to 35 per cent. of the total population; (2) that rural districts, exclusive of areas surrounding towns, included 91 per cent. of the total area; (3) that "populous" areas were less than 1 per cent. of the whole; (4) that the density of population averaged 47 per square mile in sparsely peopled districts and 103 per square mile in the better peopled rural districts. In the unprogressive districts, Mr. Welton finds much uniformity (1) in the comparative large increase of population from 1811 to 1821; (2) in the maintenance of a reduced increase from 1821 to 1841; (3) in the prevalence of low rates of increase in unprogressive towns and populous districts from 1851 to 1891; (4) in the absolute decrease of population in rural districts, with certain exceptions, from 1851 to 1891. The general inquiry brings out the vast change in the territorial distribution, the amount and the means of support of our population since 1801, and at the same time the moderate extent of country affected by the developments of this period.

THE whole of Part i. of vol. lxix. of the *Zeitschrift für wissenschaftliche Zoologie* is devoted to an important paper by Herr J. Meisenheimer on the developmental history of the bivalve mollusc *Dreissensia polymorpha*. In addition to figures in the text, the memoir is illustrated by thirteen beautifully executed plates.

WE have received the tenth annual report of the Society for the Protection of Birds. The advance of this body, both in the number of its members and in its financial resources, is reported to be steady, although its efforts might be greatly extended if a larger income were at the disposal of its council. Among the efforts of last year, a special crusade has been made against the pole-trap; and, as a model to other landlords, a paper of instructions has, by permission, been issued to the gamekeepers on the estate of Lord Barnard, forbidding the use of this instrument and the destruction of certain specified birds. The practice of ornamenting poulterers' shops with the carcasses of non-edible birds at Christmas has also been discouraged. The announcement of several clutches of great skua eggs for sale in London last June drew the attention of the Society to the necessity of further protection for the bird in question; and on their initiation a proposed sale at the same time of the eggs of other British birds taken during last season was abandoned. Attention is also directed to the resolution recently passed by the B. O. U., discouraging the collecting of eggs or skins of certain of our rarer birds. The latter part of the report deals with work abroad.

IN the *Ibis* for January, Mr. Chalmers Mitchell, from the study of the anatomy of kingfishers, makes a further important contribution to a right understanding of that peculiar feature in the arrangement of the quills of the wings of certain birds now known as "diastaxy." It will be within the recollection of many of our readers that in 1899 Mr. Pycraft and Mr. Mitchell independently made communications to the Linnean Society in which they showed that the gap which occurs in the diastaxic wing is not due to the loss of a quill, whence they were led to abrogate the original term "aquinto-cubitalism." In his own communication Mr. Mitchell showed that among pigeons both "diastaxy" and "eutaxy" (a regular series of quills) might occur, and also that the latter was the more specialised type. Similar conditions are now shown to obtain among the kingfishers, in which also, as indicated by their myology, eutaxy is the specialised modification. The gradual change from perfect diastaxy to complete eutaxy in this group is most clearly explained by the diagrams illustrating Mr. Mitchell's communication.

ARTICLE 19 of vol. xiii. of the *Bulletin* of the American Museum of Natural History contains a revised memoir on the phylogeny of the European rhinoceroses, by Prof. H. F. Osborn. The author is of opinion that the rhinoceroses (inclusive of the Siberian Elasmotherium) are divisible into six distinct phylogenetic subfamilies, three of which are represented by existing members of the family. Rhinoceros proper, he considers, is now restricted to the Indo-Malay countries, as is Ceratorhinus, as represented by the Sumatran species, the two African species being assigned to a third genus, Atelodus. More importance is attached to the structure of the skull (especially the form of the nasal bones) than to that of the molar teeth, which may have been independently modified for grass-eating in two or more species. Accordingly, Elasmotherium, in place of being considered a specialised type akin to the white rhinoceros of Africa, is affiliated to the middle Tertiary Aceratherium. Again, the great two-horned rhinoceros of the Indian Siwaliks (*R. platyrhinus*) is removed from its association with the aforesaid African species to find a position next to the living Sumatran animal.

THE Council of the Zoological Society has given instructions for the publication of an index-volume to the new generic names mentioned in the "Zoological Record," vols. xvii.–xxxvii. (1880–1900). The volumes previous to vol. xvii. have been indexed in the "Nomenclator Zoologicus" of Scudder, published by the Smithsonian Institution in 1882. The contemplated index-volume of the "Zoological Record," in order to increase its usefulness, will include names omitted from Scudder's list and from the volumes of the "Zoological Record." Thus zoologists may have at their disposal (in the "Nomenclator Zoologicus" and the new index together) a complete list of all the names of genera and subgenera used in zoology up to the end of 1900. It is requested that any one who knows of names omitted from Scudder's "Nomenclator," or from the volumes of the "Zoological Record," will forward a note of them, together, if possible, with a reference as to where they have been noticed or proposed, so that the new list may be made practically complete. Such information should be addressed to the editor of the "Zoological Record," 3 Hanover Square, London, W.; or to Mr. C. O. Waterhouse, British Museum, Natural History, South Kensington, London, who is engaged in compiling the list.

THE *Journal* of the South-Eastern Agricultural College contains an article by the Principal, Mr. A. D. Hall, on the economic aspects of the cultivation of sugar beet in England. The matter is gone into very fully, both from the point of view of utilising the produce as food for farm stock, and of the manufacture of sugar. In a feeding experiment with sheep, where mangels were tried against sugar beet, the advantage rested with the mangels, the writer's verdict being that "The superiority of the mangold is very manifest, and it is clear that it will not pay the farmer to grow sugar beet for feeding purposes." Nor, with foreign bounties on exported sugar, does it appear that there is any prospect of producing sugar at a profit in England. The writer has shown that the price obtained by the German grower cannot be looked for in this country, and concludes that "At the present price of sugar, no factory could afford to pay for sugar-beet a price that would be remunerative to the farmer." The same issue of the *Journal* also contains an article by Mr. Hall on the influence of certain manurial substances on the

quality of barley, the results of his experiments being confirmatory of the best agricultural practice, namely, that though a moderate dressing of soluble phosphate may not have much effect on the yield, it produces a marked improvement on the quality of the grain.

THE *Revue Scientifique* contains an article by Prof. Thoulet on the International Congress of Oceanography held at Stockholm in 1899. A full account is given of the proceedings and conclusions of the Congress, and Prof. Thoulet expresses profound regret at the non-participation of the French Government and at the lack of interest in the subject in France generally. A number of the physical and chemical points dealt with by a section of the Congress are discussed, and certain questions raised, particularly with regard to the specific gravity of sea-water *in situ*, which merit the attention of the Committee appointed by the Congress to report on such matters.

La Géographie contains an account of two scientific expeditions on the east and west coasts of Madagascar, by Mr. E. Colin. The work of these expeditions was chiefly topographical and magnetic. From Andevorante, Vatomandry and Mahanoro the coast turns more to the south-south-east than appears on the maps, and the positions of the two last-named towns lie more to the south. Combining the magnetic observations of 1892, 1896 and 1900 at Tamatave, Ampanotoamaisina, Andevorante, Vatomandry, Marosika, and Mahanaro, it appears that along the zone of the east coast the declination increases and diminishes alternately in the order of the stations named, the maximum occurring at Andevorante and the minimum at Vatomandry; and that the declination and dip vary in opposite directions.

A REPORT on the permo-Carboniferous Coal-measures of Clermont, by Mr. B. Dunstan, has been published by the Geological Survey of Queensland. In the district described there are several tracts of Coal-measures, the largest area exposed being that of Blair Athol. There are also tracts of granite, of slates and schists with auriferous quartz-reefs, and of Devonian and Tertiary strata. It appears that upwards of 65,000 tons of coal have been obtained from the Blair Athol coal-field during the past ten years, and that more than seven million tons of the best Clermont coal are still available. The coal is well adapted for locomotives, and has been mainly used for them. It is remarked that in the Coal-measures there are strata derived from the auriferous slates and schists, and that therefore there might have been streams entering the old Carboniferous lagoon, which brought gold into channels now hidden by more recent accumulations: hence future developments may lead to the discovery of some of these gold-bearing alluvial deposits below the coal-seams.

THE ninth course of public lectures in connection with the Childhood Society, which exists for the scientific study of the mental and physical conditions of children, will be given in the library of the Sanitary Institute on Thursday evenings during this month. The subjects will be, Food dietaries in relation to school-life, by Dr. R. Hutchinson; Examinations in their relation to mental growth, by Prof. H. L. Withers; Experimental psychology, and the study of childhood, by Dr. W. H. R. Rivers; Observations of children after the methods of natural history, by Dr. Francis Warner.

IN view of the widespread opinion that in future many of the fundamental principles of theoretical chemistry will have to find a place in elementary lectures on inorganic and analytical chemistry, we note with interest a series of lecture experiments described by Messrs. Noyes and Blanchard in the *Zeitschrift für physikalische Chemie*, vol. xxxvi. pp. 1–27. The experiments illustrate various phases of the theory of electrolytic dissociation, the laws of equilibrium in solution and the velocity of chemical reaction. They are well chosen, and the necessary details of manipulation are carefully described.

Bulletin No. 89 of the U.S. Department of Agriculture (Office of Experiment Stations) consists of a report of experiments on the effect of muscular work upon the digestibility of food and the metabolism of nitrogen, carried out at the University of Tennessee by Prof. C. E. Wait. Although the effect of muscular work has been considered already in numerous dietary studies, yet up to the present very little information in this special connection has been obtained. As a result of sixteen detailed experiments it is found that, comparing the elimination of nitrogen in the urine during the periods of little muscular activity and normal diet with that during periods of increased activity and a diet furnishing energy largely in excess of the heat equivalent of the measured work performed, there is a slight decrease under the latter condition. This is true even when the possibility of a lag of considerable duration between the breaking down of nitrogenous material within the body and the excretion of nitrogen in the urine is admitted.

AMONG the recent captures made at Plymouth by the Marine Biological Association the most noteworthy are the polychæte *Bispira voluta-cornis*, the crustacea *Galathea strigosa* and *Pirimela denticulata*, the mollusca *Lima hians*, of which many specimens were found in a small patch of muddy stones, making their nests in the crevices between the stones, *Pinna pectinata* and *Scalaria communis*, and the Blenny *Blennius galerita*, of which a small specimen was found between tide-marks. The following animals, among others, are breeding:—Crustacea: *Galathea squamifera*, *Eurynome aspera*, *Pirimela denticulata*, *Gnathia maxillaris*, *Dynamene rubra*. Mollusca: *Lacuna vincta*, *L. pallidula*, *Purpura lapillus*. Pisces: *Cottus bubalis*. An increasing number of larval forms is shown by the tow-net captures, especially of Trochospheres, Veligers, Nauplii and Zoææ. It is to be feared that the octopus (*Octopus vulgaris*) will again be in evidence this summer, as there are already records of its appearance at Plymouth and Mevagissey.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. W. Field; a White-fronted Capuchin (*Cebus albifrons*) from South America, presented by Mr. E. P. Rickcord; a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, presented by Mr. Geo. Smithers; a Blotched Genet (*Genetta tigrina*) from Africa, presented by Captain R. L. Haddock; a Slender-billed Cockatoo (*Licmetis nasica*) from South Australia, presented by Lady Gertrude Lawford; a Virginian Colin (*Ortyx virginianus*) from North America, presented by Mr. B. N. H. Jones; a White-collared Teetee (*Callithrix torquatus*) from Brazil, a Pig-tailed Monkey (*Macacus nemestrinus*) from the East Indies, a Red-bellied Thrush (*Turdus rubriventris*), a Blue-fronted Amazon (*Chrysotis aestiva*) from South America, a Rose-coloured Pastor (*Pastor roseus*) from India, two Fox Sparrows (*Passerella iliaca*), two Chipping Sparrows (*Spizella socialis*), two Snow Birds (*Junco hyemalis*), two White-throated Song-Sparrows (*Zonotrichia albicollis*) from North America, two Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, a Sclater's Cassowary (*Casuarius philipi*) from New Guinea, three Toco Toucans (*Ramphastos toco*) from Guiana, an Allen's Porphyrio (*Hydrornia alleni*) from West Africa, deposited; two Emus (*Dromaeus novae-hollandiae*) from Australia, purchased; four Chinese Bulbuls (*Pycnonotus sinensis*) from China, received in exchange.

OUR ASTRONOMICAL COLUMN.

VARIABILITY OF EROS.—In the *Astronomische Nachrichten* (Bd. 154, No. 3688), Dr. E. von Oppolzer describes his observation of the planet Eros, which led to his announcement of its variations in brightness. The measures were made with the Zöllner photometer on a Grubb refractor of 8½ inches aperture at Potsdam.

In the same journal there are further confirmatory reports from the observatories of Königsberg and Heidelberg.

NEW TYPE OF SHORTENED TELESCOPE.—In the *Astronomische Nachrichten* (Bd. 154, No. 3691), M. E. Schaer describes some experiments he has made at the observatory of Geneva with the object of facilitating the use of long focus objectives. The light from the object glass is reflected backward and forward from two silvered plane mirrors, so that the distance between eyepiece and objective is only about one-third the focal length. Good photographs of the sun's surface were obtained by using unsilvered glass mirrors and giving an exposure of about one-fiftieth of a second.

CATALOGUE OF NEW VARIABLE STARS.—Harvard College Observatory Circular, No. 54, contains a catalogue of sixty-four new variable stars discovered by the observers at that institution. The majority of these have been detected on examination of the Draper Memorial spectra, by reason of the presence of bright lines of hydrogen in the peculiar cases. For the purposes of this catalogue the variables have been divided into two main classes (1) those having a large range of variation, (2) those in which the extent of variability is small—from half a magnitude to a magnitude. The variables examined are then classified under these headings, 39 of long, and 25 of short period.

NEW COMPONENT OF THE POLAR MOTION.—In the *Astronomical Journal* (vol. xxi. No. 490), Prof. S. C. Chandler makes a preliminary announcement of the detection of a new component relating to the motion of the terrestrial pole. In addition to the already known 428-day and annual terms, he now finds a variation having a period of 436 days and a radius of 0″·09—considerably smaller, therefore, than the others. In the absence of more minute data, the orbit is assumed circular, and the author proceeds to investigate the nature of the variation produced as the resultant of the old 428-day and the new 436-day motions.

The combined motion is found to be subject to a period varying from 431·4 and 415·0 days, the mean length being 428·5 days. The fluctuations are embraced in a cycle of about 57 periods, or 67 years. With respect to the whole cycle, however, the changes of period are of a remarkable character. During five-sixths of the cycle the period remains between its mean value and the upper limit, *i.e.* between 428·5 days and 431·4 days; then it suddenly shortens to minimum, 415 days, and immediately rapidly lengthens again. In addition to this the variations of the radius of motion are also singularly asymmetrical. It is at present about 0″·07 and approaching its minimum value of 0″·05; there was a decrease from 0″·17 to 0″·11 between 1890 and 1897. It will be interesting to note whether the predicted variation of the period actually takes place. Between 1850 and 1890 it persisted at the value 430 days, is now about 428 days, and should continue to shorten to the minimum value of 415 days within the next few years; but of course no sharply-defined numerical limit can be stated on account of the fact that the length of the harmonic cycle, which depends on the difference of the two component periods, is imperfectly determined by existing observations.

INAUGURATION OF A BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

DURING the last few years, the Institution of Electrical Engineers has actively encouraged the formation of local sections, each having headquarters in some industrial centre. These local sections are free to manage their own affairs, but the parent Institution arranges that important papers read at any of the local centres are incorporated in their journal, as also are local contributions to the discussion of papers read originally in London. Of the five branches now existing, the most recently formed is that in Birmingham.

The Birmingham local section of the Institution of Electrical Engineers has been fortunate in its first chairman, Dr. Oliver Lodge, principal of the new University, who delivered an address from the chair on Wednesday evening, February 27, at the Inaugural Meeting of the section, before a large gathering of engineers. The president of the Institution, Prof. John Perry, was present to support the local movement.

In the course of some opening remarks, Dr. Lodge congratulated the parent Institution on its wisdom and enterprise in forming local branches. Multiplicity of publishing centres was bad for science; but the lack of stimulus to local exertion was bad too. By the present action of the Institution both evils were avoided.

The original Society of Telegraph Engineers dealt chiefly with cable enterprise. Then it took over successively the telephone, electric lighting, transmission of power, and tramcars; and now it seemed about to take over underground traffic, and, in some countries, the railways themselves. Again, a warship was full of electrical contrivances, and the Institution sent a corps of experts to add to the land forces in South Africa.

With regard to the engineer's education, the chairman pointed out that it must be truly scientific. Some said that a general education and mathematics were unpractical and useless encumbrances. What they really meant was that if a youth had these and nothing else he was useless, and that he would be more useful if he failed to possess these, but did possess many other powers and aptitudes. This was true; but the two were not mutually incompatible.

Mathematics, for example, was often so taught that by the time a man had acquired a great deal of it he was somewhat unfitted for anything else. A common-sense mathematical training was an essential for an engineer or for a physicist. Euclid himself was splendid. So was his book for its day and generation, and its purpose as a system of geometrical philosophy admirable; but it had had its day, and for elementary and popular purposes should now cease to be. We were too busy; there was too much to learn nowadays to have time to cross every river by ascending to its source and walking down the other side. Professional guides along the old river path still attempted to hide the bridges, because if they were too easily seen their occupation would be gone; but the bridges were there, and sooner or later even schoolboys would be permitted to make use of them and enjoy the country on the other side, without spending all their days in a toilsome and deterrent mode of getting there over a route approved by the ancients.

The pursuit of pure science for its own sake was a good and wholesome formula up to a certain point, because the tendency of unregenerate man had always been opposed to it. The usefulness of scientific application needed no preaching, but, strangely enough, there was a great tendency to forget or ignore the scientific foundation on which they rested. And the human mind was so constituted that, as a rule, the necessary powers and aptitudes for the two things did not go together. The man who could pursue pure science did so best, as a rule, when he was not distracted by considerations of utility; the applier of science, on the other hand, soon got so immersed in practical details and pecuniary considerations which were clearly vital that he had neither leisure nor inclination, nor always the right kind of ability, for advancing the pure science itself.

Pure science must always advance into territory which appeared for the moment rather useless and barren and aloof from humanity; it must be so, since it was new ground never open to humanity before. Consequently there was a weird unearthliness about it which to people engaged in the turmoil of business might be cold and repellent, if ever they allowed themselves to be assisted to breathe its atmosphere for a moment. The strange, new, unknown, bracing air had a fierce fascination of its own, akin to that of the lone ice-packs of the Arctic seas to the healthy and intrepid explorer, or as the mountain tops were to the members of the Alpine Club. So enticing did the atmosphere of pure science become to those who frequently breathed it that to them sometimes it seemed the only air worth breathing, and the everyday atmosphere of humanity was close and stifling in comparison. Let such men of genius alone; encourage them in their quest; they were not too numerous, and whither they showed the way others hereafter would follow. Moreover, the region which they entered was no limited Arctic circle in reality; it was, as it were, the Arctic entrance to another world, whence, if they penetrated further in pursuit of the pioneers, they would ultimately reach the temperate zones of work and livelihood and applied science; nor

need they doubt but that at some far distant date the human race might at length make its way on through those regions too, and attain, even by that apparently arid path, the rich tropical belt of luxurious verdure and bright sunshine where conflict ceased and art and enjoyment and emotion and religion began. Facts known to few with effort were science, but those same facts when known to all without effort were æsthetic; they could then be appreciated in a fuller and higher way, could be seen in an altogether new light, so that they became fit subjects for poetry, for music, and for art.

Meanwhile, the justification of all pure, dry science lay essentially in its ultimately human bearings. If a subject could be proved to be never capable of any human influence or any relation to humanity, however developed it might become, then its pursuit would be rightly condemned. But such proof could never be given. Again and again had the most unlikely channels developed into fruitful watercourses. We must trust the instinct of our leaders and let them advance unhampered, in the faith that where they felt so much enthusiasm, where they seemed to see their way so clearly and so well, we too, in time, or our descendants, should be able to enter with their aid, and should realise that the remote and at first sight hopelessly inaccessible region was full, after all, of human interest, and of that which contributed to the enrichment of life.

Referring to the present state of electrical knowledge, Dr. Lodge spoke as follows:—

"We are in the beginning of a great era in connection with the pure science of electricity. The almost despised and neglected subject of electrostatics, as known to Franklin, is rearing its head again and pressing to the front.

"The experiment of a charged rod and pith balls is typical of much, perhaps typical of all that goes on in electricity; and how much this means some of us are beginning to guess. It is to the works of Larmor and the late Prof. Fitzgerald that we must look for an explanation of the nature of an electric charge—that blank, that absolute void so wisely left by Clerk Maxwell in his scheme, and by Helmholtz in his—a void occupied only by the isolated brilliant surmise contained in the phrase 'one molecule or atom of electricity.'

"But even before we understand the nature of an electric charge we shall find that the labours of J. J. Thomson have enriched the science of our times with what appears likely to be a unifying and comprehensive generalisation such as philosophers of all time have groped after, for which some of them have strongly hoped."

Concluding his address, Dr. Lodge illustrated with a few simple experiments the most recent views of the nature of the electric current. The atom was ordinarily associated with a charge, and force was required to separate them. This atomic charge, when separated, was known as an electron.

In the electrolyte there was a bodily transfer of atoms with their atomic charges.

In a metallic conductor the charges were handed on as electrons from atom to atom.

But it was in the discharge through highly rarefied gases that the electric current was in its most simple form, for here there was a flow of electrons travelling by themselves, of disembodied charges or electric ghosts. It was interesting to notice that, with their enormous speed of one-tenth of that of light-wave propagation, these electrons were the fastest moving of all known terrestrial objects.

A revolving electron was a magnet. A vibrating one could start light vibrations. And it might even be that inertia itself—that familiar but unexplained property of matter—was but electromagnetic inertia in disguise.

Prof. Perry, in thanking the chairman for his address, remarked that the country was now very much alive to the need for improvement in the scientific education of practical men. All the scientific world was watching to see what Dr. Lodge was going to make of the great problem that was before him of the Birmingham University.

He deprecated the tendency in this Institution to array professors and engineers against one another, and advocated the cultivation of a spirit of mutual helpfulness as between men whose various endowments must be interdependent if they were to be fully utilised.

Prof. Perry congratulated the new local section on its successful start and on its locality, saying that the people of Birmingham were very early in introducing scientific methods of manufacture. The stress of international competition called for the greatest activity in scientific methods in all our centres. The Institution of Electrical Engineers was doing a great work and had a great future before it in binding together the best thinkers in a great association for the common good.

Prof. Threlfall seconded the motion, and the meeting concluded with a feeling reference to the untimely death of Prof. G. F. FitzGerald, who was chairman of the Dublin local section of the Institution.

THE TAMNAU MINERALOGICAL ENDOWMENT.

IN the year 1879 occurred the death of Dr. Friedrich Tamnau, a rich Berlin banker, who was also an enthusiastic collector of minerals; his collection was well known, and was frequently used by mineralogists; a considerable portion of it was given to the Berlin Museum during his life-time, and at his death the remainder was bequeathed to the technische Hochschule at Charlottenburg.

Dr. Tamnau's services to the science of mineralogy did not end with his death. He left to the University of Berlin a sum of 36,000 marks for the purpose of founding a mineralogical travelling fund.

By the statutes of the founder it is enacted that when the fund has accumulated to a sufficient extent it shall be employed in sending away a young and promising mineralogist to some interesting locality, in order to study the modes of occurrence of fine or rare minerals, to collect, and to report upon them. It is expressly stipulated that the fund is to be applied to mineralogical, not geological, purposes. The specimens are to go in the first instance to the Berlin University collection, then to the technische Hochschule, but they may also be given or exchanged to other collections. The administration of the fund is in the hands of three trustees; those named by the founder to hold office at the beginning were Profs. von Rath, of Bonn, Groth, of Strassburg, and Websky, of Berlin.

The first application of the Tamnau fund was made in sending Dr. Tenne, of Berlin, on a successful mineralogical tour in southern Spain.

Two of the original trustees are dead, and the fund is now administered by Profs. Groth, of Munich, Klein, of Berlin, and Bauer, of Marburg.

The second award, 10,000 marks, was made in 1896. Dr. F. Grünling, the well-known assistant of Prof. Groth, first at Strassburg and subsequently at Munich, and now curator of the State collection of minerals in Munich, was commissioned to undertake a mineralogical expedition in Ceylon.

The valuable results of Dr. Grünling's tour have now been published. A triple Heft (Nos. 3-5) of the thirty-third volume of Groth's *Zeitschrift für Krystallographie und Mineralogie* is almost entirely occupied by the scientific work done upon the material which was brought back from Ceylon, and those who wish to see the excellent results of a wise scientific endowment wisely administered cannot do better than glance over this publication.

Dr. Grünling brought back rich collections, especially of the dolomite and the minerals which it contains, of the graphite and of the gem-stones; among the latter the most remarkable are the tourmalines, which constitute a unique series of beautiful crystals.

All these minerals have now been examined by various workers in Prof. Groth's laboratory. The graphite has been the subject of exhaustive study by Dr. Weinschenk, the lecturer on petrology in the University of Munich, who has already published papers on the subject in the *Zeitschrift für Praktische Geologie* and in the *Abhandlungen* of the Bavarian Academy of Sciences. The dolomite has been analysed by Dr. Schiffer, whose results have been given as an inaugural dissertation. And now has appeared this triple Heft of Groth's *Zeitschrift*, containing a general description of Ceylon and its minerals by Dr. Grünling, a research upon the chrysoberyl, the sillimanite and the blue spinel by Dr. Melczer, and a voluminous report upon the tourmaline crystals by Dr. Worobieff, whose memoir occupies nearly 200 pages, and is in reality a crystallographic monograph of the mineral

The fact that so much has been achieved will suggest to the reader that the collection and scientific study of Ceylon minerals has been sadly neglected by our own countrymen. A perusal of Dr. Grünling's paper serves but to strenghten this conviction.

With the exception of an interesting paper on the graphite and rocks of Ceylon, contributed last June to the Geological Society of London by Mr. Coomára-Swámy, but published too late to be alluded to by Dr. Grünling, little has been done. Mr. Coomára-Swámy himself remarks, "No geological survey is in progress in Ceylon; it is much to be hoped that the Government will soon realise the importance of instituting one."

To give a very brief survey of the scientific results:—

Dr. Grünling makes it clear that the graphite always occurs in typical symmetrical veins, though these have been much crushed and altered by earth movements which have spent their energy upon the soft graphite, and have consequently spared the country rock (granulite). Dr. Weinschenk comes to the conclusion that the graphite is of volcanic, and certainly not of organic origin, and is probably due to the action of vapours containing carbon; he suggests that carbon dioxide and cyanogen compounds have played the chief part in its production. Among the associated minerals it is remarkable that, as at Passau, nontronite is one of the invariable decomposition products accompanying the graphite.

Dr. Grünling is of opinion that the gemstones of the sands and gravels were derived from the dolomitic limestone which abounds in some parts of the island, for the spinel, which is certainly found in the limestone, contains sapphire, phlogopite, &c., while the corundum contains phlogopite, rutile and spinel. A granular marble from Wattegama, on the Kandy railroad, proves to be a theoretically pure *dolomite*; it contains, among other minerals, a remarkable blue apatite, which has been analysed by Dr. Schiffer and is found to be a fluor-apatite containing 15 per cent. of chlor-apatite. It is curious that Dr. Grünling was unable to obtain any information concerning the original locality of the tourmalines; they are probably all derived from the cabook or laterite, and from some one place.

Worobieff's crystallographic measurements relate to 110 crystals remarkably rich in faces, and have resulted in the establishment of no less than 131 new forms; one crystal alone presented the faces of fifty-nine forms; the table of calculated angles fills forty-three pages. He finds that the symmetry of tourmaline is undoubtedly ditrigonal, and not tetartohedral as has been supposed by some authors. The paper also contains numerous observations upon the pyro-electric properties of tourmaline, and distinguishes between the faces of the analogous and of the antilogous poles.

Dr. Melczer's paper establishes beyond doubt that the chrysoberyls of Ceylon, of Brazil and of the Urals (Alexandrite) possess the same axes, and that the twinning takes place parallel to (031), not to (011). His optical study of the spinel leads him to the conclusion that the refractive index of this mineral varies with the colour; it is least in the most highly coloured parts.

The whole series of investigations reflects much credit upon the administration of the Tamnau fund, upon those who have collected and studied the minerals, and upon Prof. Groth, in whose laboratory the investigations have been successfully carried out.

The next award of this useful fund will be expected with nterest.

H. A. MIERS.

CRANIOLOGY.[1]

WE have assembled here to-day in order that we may commemorate the merits of John Hunter and such other persons whose labours have contributed to the extension of our knowledge in comparative anatomy, physiology, or surgery. Hunter's life in all its various aspects has been so frequently dwelt on in former orations delivered in this theatre that it is beyond my power to throw any fresh light on this subject. His fame is attributable to his having possessed an intense love of science, indomitable energy, and a self-reliant, manly character. If we turn to his portrait hanging on the walls of this theatre, it would seem that at the time when this likeness was painted Hunter was engaged in the study of the craniology of man and anthropoid apes, for on the table before him there is an open volume, and on its pages we see clearly drawn a human skull and the skull of a chimpanzee. Hunter is portrayed, pen in hand, in deep thought, having just turned away from the book he had been studying, and though his notes on comparative anatomy were unfortunately destroyed with his other manuscripts, we can hardly doubt that craniology was a subject in which he was deeply interested, or it would not have held so prominent a position in this famous picture. It would, therefore, seem that on an occasion such as the present we can do no higher honour to Hunter's memory and to that of some of the able men of science who have followed him than by endeavouring to give in as few words as possible a *résumé* of their labours, with especial reference to the subject of craniology and the light it is capable of throwing on the prehistoric inhabitants of western Europe and of the evolution of the race of men to which we belong. One of the most brilliant and original thinkers who has occupied the presidential chair of this college, Sir William Lawrence, in his ever-memorable lectures on the natural history of man, delivered in this college in the year 1819, from his researches in comparative anatomy, foreshadowed the idea that man and apes were derived from common ancestors. Lawrence's opinions were received with a storm of adverse criticism. Mr. Abernethy, for instance, charged him with "propagating opinions detrimental to society and endeavouring to enforce them for the purpose of loosening those restraints on which the welfare of mankind depend." Time, however, has proved that Lawrence was right, and in the course of lectures delivered in this theatre in February 1899, Prof. Keith, from a careful analysis of the maximum number of anatomical characters common to man and apes, arrived at the conclusion that they are derived from an identical or a kindred stock. While admitting without reserve that man and apes are structurally almost identical, nevertheless, as pointed out by Prof. Huxley in the year 1863, they differ very materially as regards the relative weight of their brains. The carcass of a full-grown gorilla is heavier than that of an average-sized European, but it is doubtful whether a healthy adult European's brain ever weighed less than 32 ounces, or the brain of the heaviest gorilla ever exceeded 20 ounces in weight. Although at the present time there is this marked relative difference between the weight of the brain and the form of the skulls of Europeans and apes, this was not always the case, for the calvaria of the earliest discovered human beings were in form not very far removed from those of contemporary anthropoid apes. This fact leads us to inquire into the nature of the conditions which have led to the increased capacity of the human cranium and to the vast superiority of man's intellectual endowments over those of all the other primates. If we turn to Hunter's preparations in our museum we find among them some remarkable specimens which he describes as "compressed," "unsymmetrical" human crania, which he believed were the result of premature consolidation of one or more of the sutures of the skull. Since Hunter's day various authorities have devoted much time to the subject of the abnormal closure of the cranial sutures in man; prominent among them are the names of the chief of England's craniologists, Dr. Thurnam and Dr. Barnard Davis—the splendid collection of prehistoric and other skulls made by the latter gentleman are now in the possession of our college. From evidence of this nature we have come to learn that the size and form of the skull depends to a large extent on the growth of the bones of which it is formed along the lines of the various cranial sutures.

It is well known that the frontal bone, which forms the vault of the anterior part of the cranium in the young of man and apes, is divided by a suture, and so long as this line of growth, together with the coronal and other sutures by which the frontal is separated from surrounding bones, remains open, the fore part of the skull, and with it the anterior fossæ which it encloses, can expand. But if the frontal and the other anterior sutures of the cranium consolidate early in life the fore part of the skull cannot increase in capacity beyond the size it had reached in infancy. Prof. Deneker, in his work on the embryology and development of anthropoid apes, has shown that in consequence of the early closure of the anterior sutures of the skull of these animals the fore part of their brain does not increase beyond the size it had attained at the end of the first year of life, but in man these sutures do not consolidate until a much later period, so that the anterior lobes of his brain are enabled to, and actually do, become far more perfectly developed than the corresponding lobes among apes; men of the same bulk have four times as much superficial brain surface as anthropoid apes.

Whatever other functions the anterior lobes of the brain perform, their cortical nerve elements, in conjunction with

[1] "The Hunterian Oration." Delivered in the theatre of the Royal College of Surgeons of England on February 14, by Mr. N. C. Macnamara. Abridged from the *Lancet*.

those of the other lobes of the brain, control, to a large extent, our higher intellectual faculties. If we study the collection of preparations of the brains of apes in our museum, it seems to me we shall arrive at a similar conclusion to that expressed by Prof. Edinger, which is, that the gyri of the brain of man and of the anthropoid apes are similar in character, with the marked exception of those convolutions which enter into the formation of the frontal lobes. The superior and the middle gyri of these lobes in anthropoid apes are always much shorter than they are in the brains of average Europeans, and what is of especial importance is, that in the brains of anthropoid apes the inferior frontal gyri only exist in a rudimentary condition of development; this deficiency is very marked with respect to that area of the left inferior gyrus which contains the nerve elements which control our faculty of articulate language. It seems probable that the rudimentary condition of this gyrus in apes is therefore the anatomical expression of the inferiority of these animals to man in intelligence; our intellectual development depending on our possessing the faculty of speech. It may be, anthropoid apes having only rudimentary, if any, specialised nerve centre of speech, that the other parts of their anterior lobes have remained in a comparatively undeveloped condition; whereas the left inferior frontal lobe of man's brain having become highly specialised, and, with it, his power of language, the other convolutions of his anterior lobes, which govern his intellectual faculties, have been stimulated to increased action, and in this way the characteristic expansion of the fore-brain has been evolved among all the more highly civilised races of the human family. But our contention is that the factors which govern the growth of the skull differ from those which develop the brain, and that the imperfect evolution of the frontal lobes among anthropoid apes is to a large extent due to the premature ossification of that part of the skull which encloses the fore-brain. However this may be, the possession of fully-developed anterior lobes of the brain, especially of its left inferior gyrus, is the distinctive character of the central nervous system of all those families of mankind who possess well-developed intellectual capacities. On the other hand, if we compare the skull of an Englishman with that of one of the natives of Australia, we see what a wide difference there is between the development of their frontal regions, and also as to the nature of the sutures of many of their skulls. We shall further discover, from specimens in our museum, that the inhabitants of western Europe in the later tertiary and early quaternary period, as regards the ossification and form, especially of the frontal region of their skulls, more closely resembled that of the chimpanzee than the race of men now inhabiting Europe.

Since Hunter and Lawrence's time, considerable progress has been made in the science of geology and anthropology. Nevertheless, in our search for knowledge concerning the origin and development of prehistoric man in western Europe, we are still hampered by the limited supply of his remains. It could hardly have been otherwise, considering the perishable nature of the human skeleton and the vast length of time, and the great geological changes which have occurred since man appeared in our part of the world. But we have additional evidence concerning the prehistoric inhabitants of this part of Europe, for they have left us some of their imperishable handiwork in the shape of flint and stone implements, which during the past century have been carefully studied in relation to the geological strata in which they were discovered, by Lord Avebury, Prof. Boyd Dawkins, Prof. Prestwich, Sir John Evans, the late Sir William Flower, together with many other English and foreign anthropologists. From the form and workmanship of these stone implements we are now able to classify and assign them to the various periods in which they were manufactured by the early inhabitants of our part of the world.

Up to within recent times it was held that no human beings existed on the earth before the quaternary geological epoch, but in the year 1867 the Abbé Burgeois exhibited a collection of chipped flint weapons which he had discovered in a previously undisturbed tertiary formation; it was not, however, until 1872 that these instruments were admitted to have been made by man or some other animal living previously to the commencement of the quaternary period. Precisely similar flint weapons have since been discovered in tertiary strata in various localities in Europe and in Asia. In the year 1894 Dr. Eugene Dubois found the upper part of a skull (calvaria) in close proximity to a femur and two molar teeth in a well-defined tertiary geological formation in the island of Java. Dr. Dubois was employed by the Dutch Government to examine and report on the fossil-bearing strata of Java, and while engaged on this work he discovered, embedded in a hard mass of tertiary tuffs, the bones above referred to; he brought these fossils to Europe and submitted them for examination to the leading anatomists of this and other countries. They concurred in the opinion that the femur was a human bone belonging to a man of a very low type; "and demonstrating the fact that while rendering its possessor capable of the bipedal mode of locomotion, he still retained some vestiges of adaptation to an arboreal existence." There was a difference of opinion concerning the calvaria, for it was calculated that the capacity of this skull did not exceed 850 cubic centimetres, the capacity of the largest cranium of anthropoid apes being 600 cubic centimetres. Until the Java skull was found, the earliest known human skulls had a cranial capacity of about 1220 cubic centimetres. After an exhaustive analysis of the anatomical characters of the Java calvaria as compared with the skulls of man and apes, Prof. Schwalbe has arrived at the conclusion that the Java skull, taking its capacity and form into consideration, "is on the border-line between that of man and anthropoid apes"; it is more closely allied to the skulls of the Neanderthal group of men than it is to the crania of the higher apes, but it is much nearer in form to the skulls of the chimpanzee than it is to the cranium of the average adult European of the present day. Nevertheless, from a study of the impressions of the convolutions of the brain on the interior of this calvaria it is shown that the inferior frontal convolutions are well marked and approach in form those of man; and although the superficies of this convolution is less than half that of the men of the present day, it is double that of the largest brain of any known anthropoid ape. This fact suggests that the Java man possessed in some slight degree the faculty of speech and that his intellectual capacity was higher than that of any of the anthropoid apes. The post-orbital index or narrowing of the Java skull is 19·3, as compared with the average of living Europeans, which is 12. In this measurement the Java skull comes nearer to the Neanderthal group than to that of anthropoid apes.

In the employing of skulls, which we believe to be the most trustworthy test of human races, we classify them under three heads according to the measurement of their cranial indices. In other words, the measurement of the greatest breadth of the cranium, expressed in percentage of its greatest length, is our guide as to the race to which an individual belongs from a craniological point of view. When the cranial index rises above 80 the head is called "brachycephalic," a broad head; when it falls below 75 the term "dolichocephalic," or long head, is applied to it. Indices between 75 and 80 are characterised as "mesocephalic," intermediate heads.

We have in our museum casts of two crania, and other bones, forming part of human skeletons which were found resting on a ridge of calcareous rock overlooking the river Orneau, in the commune of Spy, Belgium. These remains were unearthed with great care, and there is every reason to believe that they were originally deposited where they were discovered, being covered over with four well-defined beds of débris and clay, in which were found the bones of the rhinoceros and the mammoth, also flint weapons of the Mousterian epoch. One of these skulls has marked palæolithic characters, its brow ridges, like those of the higher apes and the Java skull, are prominent, and the forehead indicates the low type of human being of which this cranium formed a part. Its form, like that of all the other human inhabitants of Europe as yet discovered in the early geological strata of the quaternary (pre-glacial or inter-glacial) period, is of the long type; its sutures are simple and for the chief part are consolidated. We have another cast, presented to our museum by Prof. Huxley, one of our most talented and earnest workers in the science of anthropology, taken from the Neanderthal cranium. This cranium was found, with other portions of a human skeleton in a limestone cave near Dusseldorf. This cave was raised some sixty feet above the existing bed of the river Dussel, and its floor was covered to a depth of five feet by fluviatile deposits, beneath which these human remains were discovered. We have in our collection a skull of the characteristic palæolithic type, presented to the college by one of our former presidents, whose memory is treasured by all who knew him, Prof. George Busk; it was found in a layer of brecciated talus under the north front of the Rock of Gibraltar.

We have also a cast of the calvaria of one of this race found in county Sligo. Another skull of the same type was discovered at Bury St. Edmunds, with the remains of extinct animals and Mousterian flint weapons.

The anterior surface of the lower jaw among the existing races of Europe projects to form the chin. Among apes the reverse is the case, for the anterior surface of their mandibles recede. The Marlarnaud and the Naulette mandibles, of which we have casts, are evidently those of human beings; they were found in geological formations (which also contained the bones of extinct species of animals and palæolithic flint weapons). These bones are distinctly ape-like in character, having receding anterior surfaces, and also the sockets of all the molars are equal in size. The bones of the legs of these pre-glacial or intra-glacial inhabitants of Europe are of ape-like form, and together with the bones of their arms prove that they were a short, powerful race of beings whose average stature did not exceed five feet. They are known as the Neanderthal group of men.

When the glaciers which had extended over the greater part of Europe moved northward, the reindeer passed away with them from our part of the continent. These animals, which could easily be captured by man, had roamed in vast herds over the surface of the country, and had probably afforded the human inhabitants of that period living in western Europe an ample supply of food. The climate of our part of the world at the termination of the glacial period became such as we now experience. Britain was separated from France by sea, and fine rivers, containing numerous fish, filled the valleys of our land; the red deer, wild horse and various fleet-footed animals abounded in the splendid forests which overspread the country. But these animals and the fish of our lakes and rivers were not easily captured, and the human inhabitants of western Europe were therefore compelled to exert their intellectual capacities to an extent not heretofore necessary in order to supply themselves with food and with the skins of animals for clothing. Man was able to overcome the difficulties he had to face, possessing an innate power by means of which (as already explained) his brain was able to develop and so meet the increased demand made upon it in the struggle for existence. That such was the case we judge from the discovery, in geological formations of the post-glacial period, of the skulls of men having the same physical type as those of the strictly palæolithic epoch of western Europe, but with increased brain capacity. These post-glacial human skulls indicate, in my opinion, a gradual transition in form from the ape-like characters of the previous period to a higher standard and distinctly greater brain capacity in the frontal region; this most important question, however, requires further study. With this improvement in the form of the human skull, the flint, stone, bone and horn instruments made by the post-glacial inhabitants of western Europe become more highly finished, indicating the possession of increasing intellectual power on the part of those who made them.

The Engis skull, of which we have a cast, presented to this college by Sir Charles Lyell, is a well-known example of a human cranium of the early neolithic or post-glacial period. Huxley, in his description of this skull, observes: "It takes us, at least, to the further side of the biological limit which separates the present geological epoch from that which preceded it," that is, from palæolithic times. The Borris and Egisheim skulls probably belong to this period, their characters being similar to those of the Tilbury cranium described by Sir Richard Owen, of which we have casts in our museum. These and various other skulls found in geological formations of the time referred to are all of the same type, and lead us to believe that the inhabitants of Europe consisted, in the early neolithic period, of only one race, the descendants of the human beings who inhabited our part of the world during the previous or early palæolithic epoch. They had long (dolichocephalic) skulls, with slightly projecting supraorbital ridges, well-formed noses, and a fairly-developed frontal region as compared with the far more ancient Java and Neanderthal crania. Their lower jaws and the bones of their legs were less simian in character than those of their remote progenitors; they were a small race of beings. We find no metal weapons or instruments with their remains, and we therefore conclude that they were ignorant of the use either of bronze or of iron, nor do they seem to have possessed domestic animals or to have had any knowledge of agriculture. This race of primitive inhabitants of western Europe are best known as the Iberians, and we may conveniently employ this term so long as it is understood to designate the Africo-European stock who were, so far as we know, the only human inhabitants of Europe in the later palæolithic times. It should be clearly understood that no *bonâ-fide* human remains belonging to the early palæolithic period have hitherto been discovered in western Europe which were not of the same type as those above described.

As we pass from the early to the mid-neolithic epoch, we come upon the remains of a race of men who, as regards their physical character and state of civilisation, essentially differ from the people above referred to. The stone implements found with their skeletons are beautifully formed, many of them being highly polished and having sharp cutting edges. A few of the purest bronze axe-heads have been discovered with these remains, and also the bones of domestic animals belonging to species indigenous to Asia but foreign to the palæolithic fauna of Europe. Lastly, we have evidence that these people were acquainted with agriculture and with the manufacture of sun-dried pottery. They paid great respect to their dead chiefs, burying their bodies in natural caves or in tombs formed of huge flag-stones placed edgeways side by side with similar stones laid on the upright ones to form the roof of the building. These structures, the well-known long dolmens, have been found, built on precisely the same plan, in Ireland, England, the greater part of Europe, the west of Asia, India, Arabia and northern Africa. They were not only sepulchres for the dead, but many of them also contained an altar, a place of mourning and of offering, where intercession was made to the spirits of departed chiefs by their relations and tribesmen. The Rodmarton long dolmen or temple tomb (near Cirencester) affords us a good example of one of these structures; it is 180 feet in length and 70 feet broad. We have in our museum a fine human skull which was found in this dolmen, with some well-polished stone implements. If we compare the skull with that of palæolithic man or with the skulls of the early neolithic human inhabitants of western Europe, we are immediately struck by the marked difference that exists between them and the Rodmarton skull. Dr. Thurman's unique collection of crania may be seen in the Anatomical Museum, Cambridge; these crania, for the most part, were unearthed by himself from various English long dolmens and barrows, and they resemble in form, although they are of a higher type than, the skulls found in the caves of Cro-Magnon and Mentone; they are identical in character with skulls found in the long dolmens of France and other countries of Europe. The cranial index, capacity, and other features of the bones of these skulls lead us to assign them all to one and the same race, of which the Cro-Magnon are probably some of the very earliest specimens as yet discovered in western Europe. The three Cro-Magnon and three Mentone skeletons were those of people some six feet four inches and upwards in stature, so that a race of giants in far distant times was no myth. Their cranial capacity was above that of average Europeans of the present day. From their physical conformation and from the remains of the animals found buried with them, which are of Asiatic species, and from other evidence, we are led to the conclusion that the Cro-Magnon race represents the advance guard of the proto-Aryan human family, of which the Rodmarton and many other long dolmen skulls show a more advanced type. These people in far distant ages migrated from the east into western Europe, and from thence spread into our islands; southwards they passed into India, Persia and Arabia, Asia Minor and northern Africa. Over this vast area and far away in eastern Asia we find their remains, with flint and stone implements of the early neolithic type, buried in long dolmens or barrows. The roots of many of the words used by this ancient people exist in most of the languages now spoken in Europe, and their religious sentiments, myths, and, above all, their racial, mental and physical characters, as portrayed in the Rig-Veda and on the ancient monuments of Egypt, are pronounced features in the existing Teutonic and Anglo-Saxon people. From the form of the crania found in many of these long dolmens we know that this tall, fair, handsome, long-skulled race intermarried with the pre-existing short dark Iberian inhabitants of Europe. The fair tall race probably did not at any time, unless in the north of Europe, form a large proportion of the population; they were a dominating, fighting and priestly caste who compelled the primitive small, dark (Iberian) inhabitants of western Europe to work as their slaves.

During the neolithic era, while the descendants of the proto-Aryan stock were slowly feeling their way from the

East along the valley of the Danube into Europe, a very different race was passing from northern Asia into the Baltic provinces. These people formed settlements on the islands of Denmark and westward as far as the north of Ireland. They were the first of the broad-skulled races of the human family who had entered Europe. Their skulls were brachycephalic in form with broad faces and noses, the latter being deeply concave at the base. Their remains are found in the islands of Denmark, especially that of Möen, also in Yorkshire and county Antrim, in which localities their descendants may still be recognised by their physical characters. These people belonged to the stone age of Europe, and by comparing their skulls with those of the Rodmarton or Cro-Magnon crania we see the great difference in form of the prehistoric long and the broad-headed races of men. Until the close of the neolithic epoch there were, therefore, three pure races who formed the sole human inhabitants of Europe, with the exception of those who were the outcome of the intermarriage of the people of these three races with one another.

Passing from the neolithic to the succeeding bronze age, we find that Europe, including our islands, was overrun by a small, olive-coloured, broad-skulled people having characteristic Mongolian features. These were the lake-dwellers of Switzerland and other parts of Europe. They were traders in bronze, and probably, as Prof. G. Mortillet and other authorities hold, they gradually replaced stone, horn and bone with bronze instruments and weapons, effecting in this way a great revolution in the social and industrial habits of the pre-existing inhabitants of western Europe. In these far distant times deep mining operations were out of the question. Superficial copper ores were abundant in most parts of Europe and Asia, but alluvial tin was extremely scarce on our continent, and it is still only found in large quantities in south-eastern Asia. Cornwall, the Scilly islands, the south of Ireland, and some few other places also contained superficial ores of tin. It seems probable that the Mongolians inhabiting the highlands of south-eastern Tibet long before the commencement of the bronze age in Europe spread into Burma, the Malay Peninsula and Cochin China, and there acquired the art of mixing copper and tin in such proportions as to form bronze, the weapons and instruments which they manufactured of this metal being a ready and profitable source of barter in Europe. Together with the broad skulls and other remains of these people we find in the débris of the lake dwellings numerous ornaments made of jade, nephrite and chloromelanite, minerals found in large quantities in south-eastern Asia but not in Europe; and, lastly, vases on which are depicted people in oriental costume and instruments used only by the south-eastern Tibetans have been discovered in connection with the remains of the lake-dwellers and the round or oval burrows of Europe. These people, as a rule, cremated the bodies of their dead, and numerous cinerary urns containing their remains are found scattered over the Wiltshire and other ranges of hills in the south of England. Some of their skeletons, however, have been discovered in the round barrows which are so numerous in many parts of England, Ireland and throughout Europe and Asia. With these remains bronze instruments have been found, indicating, like the stone implements of palæolithic man, various stages of excellency in workmanship. One of the finest skulls in our museum was taken from a round barrow at Codford, Wilts. The form of this brachycephalic skull, together with its nasal bones and orbits, are characteristic of the southern Mongolian race, well known to us as the Gurkhas and Burmese of our Indian empire; a lazy, bright, rollicking, fighting people, intensely superstitious and home-loving—"the Irish of the East" as they have been aptly called. In the course of many centuries the Mongolian people of western Europe have become absorbed into the pre-existing Ibero-Aryan population and a cross-breed has resulted, and from this stock the ancient British people of our islands were derived. Their skulls are mesocephalic (a combination of the long and broad skull) and are amply represented in our museum, the cephalic indices being about 78. Subsequently to the bronze age the ancient Britons were well-nigh exterminated in England by Teutonic races who invaded our country from the north of Europe, the Anglo-Saxons taking the place of the pre-existing ancient British population of England and Scotland. Nevertheless, in some districts of England, such as North Bedfordshire, a number of the descendants of the ancient British stock continue to flourish up to the present day, as also in the greater part of South Wales, much of Cornwall, and the south and west of Ireland, the upper classes in Ireland being clearly derived from the ancient Aryan stock who passed from Gallia into that country during the neolithic period.

We possess the measurements of the heads of some 25,000,000 of the present inhabitants of Europe and the United States of America. From these measurements we learn that a large proportion of the people now dwelling in the countries bordering on the Mediterranean Sea are a short, brunette, long-skulled race, descended, we believe, from those who, from the form of their skulls and other physical characters, occupied that part of Europe and the north of Africa in far distant ages—the Iberian race. Scandinavia and North Germany are inhabited by a tall, fair, long-skulled people, derived from the proto-Aryan races who settled in that part of our continent in the neolithic epoch. A vast triangle, having its base in eastern Russia and its apex on the Atlantic in south-western France, is inhabited by a broad-skulled people derived from Mongoloid or Turanian ancestors. We do not for a moment affirm that these races, as such, have remained pure, far from it, but the results of the measurements of the heads of a great number of the existing inhabitants of Europe point to the conclusions above indicated; and this idea is confirmed by the indices of the splendid collection of crania which occupy so large a space in the museum of this college—a collection which was commenced by John Hunter and upon which a great amount of time and labour has been spent in describing and classifying the skulls which it contains; a work which, in my opinion, should be completed up to the end of the past century.

The characteristic physical type of palæolithic man may be still recognised among the inhabitants of western Europe, although their skulls have grown more capacious, especially in the frontal region. This change in the form of the cranium marks a corresponding advance in the capacity and organisation of the brain, and consequently of the intellectual ability of man: it is, in truth, evidence of his inherent power to overcome the demand made on his mental capacity in order to cope successfully with his ever-increasing struggle for existence, consequent on the growth in number of his fellow-creatures and the more complicated social conditions of his surroundings. Doubtless the form of skull of a large proportion of the inhabitants of our island indicates a cross-breed formed by the intermarriage of the long and broad-skulled families of man who in distant ages met and intermarried in western Europe, thereby improving the stock of their descendants. Races of men, such as the natives of Australia, who have remained in an unchanged environment and without intermarriage with other people, have made but little progress in their intellectual capacity, the form of their skulls continuing of the same type as those possessed by the palæolithic inhabitants of Europe.

The same causes to which we have referred, acting for long periods of time on people of the same race, have led, not only to the hereditary transmission of their physical characters, such as those existing respectively among the northern, central and southern inhabitants of Europe, but have also developed specialised areas of nerve structure in their brains, by means of which they have come to think, feel and reason alike. In this way we are able to comprehend the source and the meaning of large bodies of men belonging to the same race being frequently moved to take common action on matters affecting the well-being of their race; they possess, in fact, like innate sentiments although separated from one another by great distances and living under diverse climates and environment. Their emotions and ideals harmonise because their progenitors existed for many ages under similar external conditions and consequently developed like specialised nerve-centres, which have been transmitted, together with their physical characters, to their successors and become crystallised in their laws and reflected in their conceptions of religion as well as in their social institutions.

In illustration of our meaning we may refer to those revolting pages of history during which Belgium and the Netherlands passed under the dominion of Spain; the Iberian dominating for the time being over a thoroughly Teutonic race. Or we may contrast the existing condition of the Iberian population of South America with the Teutonic Anglo-Saxon inhabitants of the United States, or between the latter and the negro population of America, a subject which is more fully elucidated in my book "On the Origin and Character of the British People."

We have a chart here which shows the result of the recent general election held in this country; the question at issue was one in which the whole of the people in Great Britain were deeply interested. It is remarkable what a large proportion of

the inhabitants of England and of Scotland, mainly of Anglo-Saxon origin, voted together on this subject; whereas a contrary opinion regarding this same question was held by the greater proportion of the people of Ireland, and to a large extent by the Welsh, most of whom are derived from Ibero-Mongolian ancestors. It is difficult to account for the diversity in the sentiments of the people above referred to unless we consider it due to their racial mental qualities. Environment has doubtless played an important part in the evolution of these people, but their inherited racial character has had more to do with the position which the Anglo-Saxon race has gained in the world than the mineral wealth, climate, or protection afforded us by our seagirt coast.

The environment under which even a few generations of men exist would seem capable of influencing the structure of their central nervous system, as illustrated by comparing the mental qualities of our rural and urban population. The conditions under which the city-bred person, child and man, lives engender in the course of a few generations an unstable state of nerve structure, resulting in an excitable character which, if carried beyond a certain point, leads to unsoundness of mind, and may account for the increasing number of lunatics in this and the other large cities of Europe. General Sir Redvers Buller, again, in speaking of the soldiers under his command in South Africa, refers to the fact that our city-born men have imperfect sight compared with men reared in the open plains of the Transvaal, thus affording us another example of the effects of environment on the race. These are a few of the many interesting and important subjects which arise in connection with the study of anthropology, including craniology; and the contents of our museum and library offer unrivalled opportunities to the student seeking for knowledge in those branches of science.

In conclusion, as already stated, much of Hunter's reputation was founded on the result of his labours in those branches of science which tend to elucidate man's nature; and during the past century a succession of English surgeons has carried on the work commenced by our great master, enriching our museum and endeavouring to make this college, not only an examining and licensing body, but, what it certainly should be, an imperial institution for the cultivation and diffusion of those departments of knowledge which bear on the art and science of surgery. The ideas entertained by John Hunter's immediate successors on this subject were ably stated by Sir William Lawrence in his lectures already referred to. He observes that "our own individual credit, and the dignity, honour and reputation of our body, which we are bound to maintain, demand that surgeons should not be behind any other class in the possession either of the cultivation of branches of knowledge directly connected with surgery or in any of the collateral pursuits less immediately attached to it. It is only in reference to such views and objects that the Hunterian collection could have been accepted or can be of any use to this college." Hunter would, if he had still been with us, have thrown all his indomitable energies into the successful working of such an institution, and amidst the turmoil, strife and competition going on around him would, as we see him in this picture, have been engaged in the earnest, accurate, patient study of nature. It remains for our younger members to emulate the example set them by John Hunter, and by such service to secure for themselves lasting satisfaction, and beyond that add to the real dignity and utility of their college and their profession.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 222nd meeting of the Junior Scientific Club was held on Friday, February 22. Mr. H. B. Hartley (Balliol) read a paper entitled, "Polymorphism; an Historical and Experimental Account," which was followed by a paper by Prof. Townsend entitled, "The Conductivity of Gases."

CAMBRIDGE.—The subject for the Adams prize in 1903 is, "The bearing on mathematical physics of recent progress in the theory of the representation of discontinuous quantity by series, with special consideration of the logical limitations of the processes involved." The prize is open to all graduates of the University, and is of the value of 225*l.* Essays are to be sent privately to the Vice-Chancellor by December 16, 1902.

The tender for the new School of Botany, to be erected behind the Sedgwick Museum, amounts to some 23,000*l.* It is recommended for acceptance by the syndicate.

AN animated debate occurred in the House of Commons on Tuesday on the attitude taken up by the Board of Education towards higher-grade elementary schools in which science is taught, leading to the judgment in the case of "Regina *v.* Cockerton," that grants made by School Boards for scientific instruction are illegal. In the course of his reply to various criticisms, Sir John Gorst said that the Government proposed to introduce a Bill for the creation of secondary education authorities having power to provide instruction in subjects that were not contained in the Elementary Day School and Evening Continuation School Code. He agreed that we should not have a proper system of education until one authority was established in a district, having control over schools of every kind and every grade. If a change of that kind were made, overlapping would cease and the existing chaos would disappear.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 7.—"The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers." By James Dewar, M.A., LL.D., F.R.S., Professor of Chemistry at the Royal Institution, and Jacksonian Professor, University of Cambridge.

In a former paper it was shown that a platinum-resistance thermometer gave for the boiling point of hydrogen $-238^\circ{\cdot}4$ C., or $34^\circ{\cdot}6$ absolute. As this value depended on an empirical law correlating temperature and resistance which might break down at such an exceptional temperature, and was in any case deduced by a large extrapolation, it became necessary to have recourse to the gas thermometer. The gases used as thermometric substances were hydrogen, oxygen, helium and carbonic acid.

Taking the average values given by the experiments as being the most probable, then the boiling point of oxygen is $-182^\circ{\cdot}5$ and that of hydrogen is $252^\circ{\cdot}5$, or $20^\circ{\cdot}5$ absolute. The temperature found for the boiling point of oxygen agrees with the mean results of Wróblewski, Olszewski and others. If the boiling point of oxygen is raised to -182°, which is the highest value it can have; then an equal addition to the hydrogen value must follow, making it then -252° or 21° absolute. In a future communication the temperature of solid hydrogen will be discussed.

February 14.—"On the influence of Ozone on the Vitality of some Pathogenic and other Bacteria." By Dr. Arthur Ransome, F.R.S., and Alexander G. R. Foulerton.

The experiments have shown that ozone in the dry state, and in such strength as the authors used it, has no appreciable action on the vitality of the various bacteria experimented with, and, so far, the results are in accordance with those of Sonntag and Ohlmüller. Nor did a prolonged exposure to the action of ozone diminish in any way the pathogenic virulence of *B. tuberculosis* in sputum. Single experiments would also tend to show that ozone can have little, if any, effect on the pathogenic virulence of *B. mallei* and *B. anthracis.*

On the other hand, the experiments would appear to confirm the conclusion arrived at by Ohlmüller as to the bactericidal property of ozone when passed through a fluid medium containing bacteria in suspension.

A comparison of the inactivity of ozone as a disinfectant in the dry state with its action in the presence of water suggests a superficial resemblance with other gases, such as chlorine and sulphur dioxide. In the absence of further experiment, however, it would not be possible to press the analogy too closely.

In the dry state, and under the conditions in which it occurs in nature, ozone, then, is not capable of any injurious action on bacteria so far as can be judged from the experiments; and it is concluded that any purifying action which ozone may have in the economy of nature is due to the direct chemical oxidation of putrescible organic matter, and that it does not in any way hinder the action of bacteria, which latter are, indeed, in their own way, working towards the same end as the ozone itself in resolving dead organic matter to simpler non-putrescible substances.

"On the Functions of the Bile as a Solvent." By Benjamin Moore and William H. Parker. Communicated by Prof. E. A. Schäfer, F.R.S.

In this paper evidence is brought forward that the bile exercise

an important action as a solvent, and the authors claim that this is the chief, if not the only function of that secretion. It is pointed out that the bile in this respect has a twofold action: first, in aiding in the excretion of cholestearin and lecithin; and, secondly, in aiding in the absorption of fatty acids and sodium soaps from the intestine. All these substances possess a low solubility in water, and have their solubility increased in bile chiefly by virtue of the properties of the bile salts. The fact that cholestearin is still but slightly soluble in bile explains the well-known fact that gallstones are composed almost exclusively of that substance, while lecithin is very soluble in bile and hence is never deposited. This view as to the action of the bile also furnishes an easy explanation for the so-called "circulation of the bile." It further explains the faulty absorption of fat in the absence of either bile or pancreatic juice, and the almost complete failure of fat absorption when both these secretions are excluded from the alimentary canal.

"On the Application of the Kinetic Theory of Gases to the Electric, Magnetic, and Optical Properties of Diatomic Gases." By George W. Walker, B.A., A.R.C.Sc., Fellow of Trinity College, Cambridge, Sir Isaac Newton Research Student. Communicated by Prof. Rücker, Sec. R.S.

Zoological Society, February 19.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Dr. W. G. Ridewood exhibited some microscopic preparations of the hairs of three species of zebra, viz. *Equus burchelli*, *E. zebra* and the newly described *E. johnstoni*, in order to show that the hairs of the last-named animal agreed in structure with those of the other two zebras. A letter received from Prof. Ewart on the same subject stated that he was quite of the same opinion.—Mr. F. E. Beddard, F.R.S., exhibited and made remarks upon a specimen of a female Schmidt's monkey (*Cercopithecus schmidti*) with four mammæ.—Mr. R. Lydekker, F.R.S., described, under the provisional name *Sotalia borneensis*, an apparently new species of estuarine dolphin from Borneo, a specimen of which had recently been received at the British Museum.—Mr. Lydekker also gave a description of the Kashmir ibex (*Capra sibirica sacin*), and pointed out the differences between this and the three other races of *Capra sibirica*.—Mr. F. E. Beddard, F.R.S., read a paper on the broad-nosed lemur (*Hapalemur simus*), which dealt with the points of difference in structure between this species and *H. griseus*.—A communication from Dr. J. G. de Man contained a description of *Potamon* (*Potamonautes*) *floweri*, a new species of crab obtained by Captain S. S. Flower on the Bahr-el-Gebel, during his expedition up the White Nile in 1900, and remarks on other species of Potamon.—Mr. R. H. Burne read a paper entitled "A Contribution to the Myology and Visceral Anatomy of the Fairy Armadillo (*Chlamydophorus truncatus*)," in which the myology of this rare Edentate was reviewed, with special reference to the two previous descriptions by Hyrtl and Macalister, and features were pointed out in which this individual showed a greater similarity to *Dasypus* than those hitherto examined.—Dr. C. I. Forsyth Major read a paper on some characters of the skull in lemurs and monkeys, in which he pointed out, amongst other results, that the *os planum* of the ethmoid, about which some doubts had existed as to its presence in lemurs, was found to occur in the young stages of many of these animals, and that the facial expansion of the lachrymal bone in the lemurs as well as in the monkeys was not a primitive condition but an extreme specialisation.—Mr. Martin Jacoby read a paper containing descriptions of fourteen new species of phytophagous coleoptera of the family Chlamydæ.

Royal Meteorological Society, February 20.—Mr. W. H. Dines, president, in the chair.—Mr. E. Mawley presented his report on the phenological observations for 1900. During the greater part of the winter and spring the weather proved cold and sunless, but in the summer and autumn the temperature was, as a rule, high and there was an unusually good record of bright sunshine. As affecting vegetation the two most noteworthy features of the phenological year ending November, 1900, were the cold, dry and gloomy character of the spring months and the great heat and drought in July. Throughout the whole of the flowering season wild plants came into blossom much behind their average dates, indeed later than in any year since 1891. Such spring emigrants as the swallow, cuckoo and nightingale were also later than usual in visiting these shores. Taking the British Isles as a whole, the crops of wheat, barley and oats were all more or less under average. The yield of hay was poor in the southern half of England, but elsewhere varied from a fair to an abundant crop. Turnips and swedes were almost everywhere deficient, but there was a heavy crop of mangolds. Potatoes were under average. This was a bountiful year as regards fruit, the yield of apples, plums and all the small fruits being in excess of the average.—Mr. A. E. Watson read a paper entitled "A review of past severe winters in England with deductions therefrom." From an examination of the records of the severe winters of the last 300 years, he has come to the conclusion that they are most frequent in the years with the numbers 0–1 and 4–5. He is also of opinion that the severe winter in the middle of each decade is generally a late one (January to March) while that at the beginning or end of each decade is generally an early one (November to January).

MANCHESTER.

Literary and Philosophical Society, February 19.—Prof. Horace Lamb, F.R.S., president, in the chair.—Mr. Charles Bailey made a communication entitled "On *Ranunculus Bachii*, Wirtgen, as a form of *Ranunculus fluitans*, Lamarck." This aquatic plant is very polymorphic, as seen in the series of British examples exhibited. In the south of England, the stout stems are several feet in length, the leaves and peduncles are from six inches to a foot long, and the flowers are as large as a shilling or a florin. It is a frequent plant in the Herefordshire Wye and in the Severn, but in the immediate neighbourhood of Manchester it has been gathered in but one station, viz., the Derbyshire Derwent, at Whatstandwell. The plant occurs in canals and swift-running brooks, but its most congenial station is a well-filled river. It becomes less frequent in Great Britain as one ascends northwards, and just manages to occupy a few of the southern counties of Scotland. The range of examples exhibited showed that there exist all intermediates between the diminutive form collected at Ayton in the north, and the nine or ten feet plant of the New Forest in the south. Mr. Bailey's conclusions regarding this plant accord with Wirtgen's later view of it, namely, that the differences between it and the type are merely comparative.—Mr. R. S. Hutton exhibited an almost exact reproduction of Moissan's electric furnace, which has been set up at the Owens College. There it is possible, with a 50 horse-power engine, to produce a current of 700 amperes at 50 volts, and by that means it is anticipated that researches at the high temperatures thus available—viz., 3500° C., or higher—will shortly be able to be carried out. Graphite prepared in electric furnaces was also shown, as well as specimens of various carbides, carborundum, &c., from the Niagara works. The specimens exhibited illustrated the facility with which some of the rarer metals now become available, those shown being chromium and manganese. A modern form of the Lippmann electrometer was also exhibited by Mr. Hutton.

PARIS.

Academy of Sciences, February 25.—M. Fouqué in the chair.—The appearance of a new star in the constellation of Perseus, by M. Loewy. This star, when discovered by Dr. Anderson, at Edinburgh, on February 21, was of the magnitude of 2·7. Two nights later it was estimated by M. Robert, at Saint-Jean-d'Angély, as being of the first magnitude.—Studies on the agricultural value of land in Madagascar, by MM. A. Müntz and E. Rousseaux. The soil of the belt on the coast line from its composition would probably prove fertile, but the ferruginous earths of the central *massif* are poor and unfit for culture, except at the bottoms of the valleys. The island, taken as a whole, is poorly provided with the materials necessary for plant growth, and it does not appear likely that it could ever support a dense population.—On the appearance of a new star in the constellation of Perseus, by M. Flammarion. A letter to the Permanent Secretary containing the results of observations on the new star, by MM. Lucien Bosc, A. Robert, Lotte, and Bruguière.—On the variations in magnitude and position of the satellites of Jupiter, revealing the existence of a cosmic atmosphere, by Dom Lamey. The observations recorded by the author can only be satisfactorily explained by the assumption of the existence of an atmosphere in the form of a ring, composed of a material too subtle to condense, but sufficiently dense to modify by refraction the images of stars traversing it in the equatorial plane.—On a certain category of transcendental functions, by M. Edmund Maillet.—The superficial traces left by the tools in the operation

of sawing metals, by M. Vasseur. From the analysis given, it would appear that the lines discovered by M. Fremont have no relation with the curves of distribution of deformations in metals, but depend upon the nature and condition of the saw employed.—On the insulating properties of snow, by M. Bernard Brunhes.—On certain conditions of reversibility, by M. Albert Colson. The reversibility of the reaction between carbon dioxide and silver oxide is dependent upon the presence of water vapour.—The compressibility of solutions, by M. Guinchant. Up to a pressure of four atmospheres the volume of the dissolved body is independent of the pressure.—Contribution to the study of indium, by MM. C. Chabrie and E. Rengade. On prolonged boiling, cæsium indium alum deposits pure indium oxide. Determinations of the molecular weight of indium acetylacetonate in boiling ethylene bromide are consistent with the trivalency of this element.—On a new crystallised sulphate of molybdenum, by M. Bailhache.—Some new reactions of organo-metallic derivatives, by M. E. E. Blaise. A mode of synthesis of alkyl-ketonic esters.—Action of the organo-metallic derivatives upon alkyl esters, by M. A. Behal. The final product of the action of an excess of magnesium iodoethylate upon an ester, R.CO.OEt, is an ethylenic hydrocarbon, $R.C(CH_3):CH_2$.—Synthesis of tertiary alcohols in the fatty series, by M. Henri Masson.—On the absorption spectra of the indophenols and the colouring matters derived from triphenylmethane, by MM. C. Camichel and P. Bayrac.—On the constitution of glucose, by M. L. J. Simon.—The diastatic actions of colloidal platinum and other metals, by M. G. Bredig. A solution of colloidal platinum shows a remarkable analogy with the enzymes in its catalytic action towards hydrogen peroxide. Both the colloidal metal and the enzyme increase in activity with increasing temperature up to a certain point, and then fall off, and both are similarly influenced by the addition of minute quantities of hydrocyanic acid or sulphuretted hydrogen.—The function of the peritoneal canals, by M. S. Jourdain.—The action of chloroform upon the reducing action of the blood, by MM. M. Lambert and L. Garnier.—On the identity of the modifications of structure produced in vegetable cells by cold, plasmolysis, and by drying, by MM. L. Matruchot and M. Molliard.—Food value and culture of the furze, by M. A. Ch. Girard.—The examination of a meteorite which fell in the island of Ceylon on April 13, 1795, by M. Stanislas Meunier.

DIARY OF SOCIETIES.

THURSDAY, MARCH 7.

ROYAL SOCIETY, at 4.30.—Further Observations of Nova Persei: Sir Norman Lockyer, F.R.S.—Some Physical Properties of Nitric Acid Solutions: V. H. Veley, F.R.S., and J. J. Manley.—The Anatomy of Symmetrical Double Monstrosities in the Trout: Dr. J. F. Gemmill.—Preliminary Communication on the Œstrous Cycle and the Formation of the Corpus luteum in the Sheep: F. H. A. Marshall.—To be read *in title only*: On the Composition and Variations of the Pelvic Plexus in *Acanthias vulgaris*: R. C. Punnett.—On the Heat dissipated by a Platinum Surface at High Temperatures. IV. High Pressure Gases: J. E. Petavel.

LINNEAN SOCIETY, at 8.—A Contribution to the Fresh-water Algæ of Ceylon: Messrs. W. West and G. S. West.—On Mediterranean Malacostraca: A. A. Walker.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Insulation on Cables: M. O'Gorman.

CHEMICAL SOCIETY, at 8.—(1) Nomenclature of the Acid Esters of Unsymmetrical Dibasic Acids; (2) Additive Compounds of α- and β-Naphthylamine with Trinitrobenzene Derivatives; (3) Acetylation of Arylamines: J. J. Sudborough.—Formation of Amides from Aldehydes: R. H. Pickard and W. Carter.

RÖNTGEN SOCIETY, at 8.—Exhibition of Skiagrams and Apparatus.

FRIDAY, MARCH 8.

ROYAL INSTITUTION, at 9.—Vitrified Quartz: W. A. Shenstone, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Partial Solar Eclipse, 1900 November 22, observed in Western Australia: W. E. Cooke.—On the Observation of Position Angles of Polar Double Stars: R. T. A. Innes.—On the Oxford Photographic Determinations of Stellar Parallax; Reply to the Criticisms of Sir D. Gill: H. H. Turner.—Occultation of Jupiter and his Satellites, 1900, September 29: John Tebbutt.—Cape Double Star Results, 1900: Royal Observatory, Cape of Good Hope.—The Nearest Approach of Two Planets: C. T. Whitmell.—Observations of Leonids, 1900 November 15, 16: Royal Alfred Observatory, Mauritius.—Description of a Floating Photographic Zenith Telescope, and some Results obtained with it: Bryan Cookson.—Note on Mr. Cookson's Paper on the Accuracy of Eye Observations of Meteors: H. C. Plummer.—The Variable Star R Centauri: A. W. Roberts.—On the New Star in Perseus: A. Stanley Williams.—*Probable papers*: Photographic Positions of Nova Persei and Neighbouring Stars: University Observatory, Oxford.—Spectrum of Nova Persei: H. F. Newall.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Sewage Treatment: C. Johnston.

PHYSICAL SOCIETY, at 5.—A Theory of Colloidal Solutions: Dr. F. G. Donnan.—Exhibition of Apparatus: R. Appleyard.—On the Production of a Bright Line Spectrum by Anomalous Dispersion and its Application the "Flash Spectrum": Prof. R. W. Wood.

MALACOLOGICAL SOCIETY, at 8.—Note on the Anatomy of *Thersites* (*Hadra*) *bipartita*, Fer.: S. Pace.—New Marine Shells from "the Kowie" of South Africa; G. B. Sowerby.—New Marine Shells from the Philippines, &c.: G. B. Sowerby.

SATURDAY, MARCH 9.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

MONDAY, MARCH 11.

SOCIETY OF ARTS, at 8.—Electric Railways: Major Philip Cardew.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geography of the North-West Frontier of India: Col. Sir Thomas H. Holdich, K.C.I.E., C.B.

TUESDAY, MARCH 12.

ROYAL INSTITUTION, at 3.—The Cell as the Unit of Life: Dr. A. Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Æsthetic Treatment of Bridge Structures: J. Husband.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Apochromatic Collinear Lens: Dr. Harting.

WEDNESDAY, MARCH 13.

SOCIETY OF ARTS, at 8.—The Proposed High-Speed "Monorail" between Liverpool and Manchester: F. B. Behr.

THURSDAY, MARCH 14.

ROYAL SOCIETY, at 4.30.

ROYAL INSTITUTION, at 3.—Greek and Roman Portrait Sculpture: Prof. Percy Gardner.

MATHEMATICAL SOCIETY, at 5.30.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Growth and Trend of Indian Trade—a Forty Years' Survey: H. J. Tozer.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Notes on Polyphase Substation Machinery: A. C. Eborall.

FRIDAY, MARCH 15.

ROYAL INSTITUTION, at 9.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Combined Trolley and Conduit Tramway Systems: A. N. Connett.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Enteric Fever Mortality in Copenhagen from 1828–1898: Dr. N. P. Schierbeck.—The Effect of Sewerage and Water Supply upon the Behaviour of Enteric Fever in Buenos Ayres: Dr. J. T. R. Davison.

SATURDAY, MARCH 16.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

CONTENTS.

THURSDAY, MARCH 14, 1901.

A MANUAL OF MEDICINE.

A Manual of Medicine. Edited by W. H. Allchin, M.D., F.R.C.P., F.R.S. Edin. Vol. i. Pp. viii + 442. Plates 2; and Vol. ii. Pp. viii + 380. Plates 2. (London: Macmillan and Co., Ltd., 1900.) 7*s.* 6*d.* net each.

THE work before us is to consist of five volumes, and will thus eventually cover some 2000 pages; the term manual, therefore, by which it is designated, applies rather to each individual volume than to the whole work. It is essentially a system of medicine. It can be seen at a glance that the book is of an essentially different type from Allbutt's system, recently completed. It deals much more succinctly with the respective subjects, and contains no bibliographies. We assume from this—there is no preface—that the work is intended not so much for a book of reference as a text-book for students, and as a handy reference book for practitioners. In the space at our disposal it is impossible to consider at all fully the two volumes before us, and nothing remains but to take a few of the most important monographs as types.

Vol. i. begins with an introduction by the editor, in which he discusses the bases of our conception of disease and the classification of diseases. He concludes by adopting the orthodox classification, viz. local, or diseases of individual organs, and general, or those diseases in which the entire body is concerned and no preponderance of symptoms in one region occurs. It is with this latter class of diseases that both the volumes before us are concerned. The general diseases are again divided into those of extrinsic and intrinsic origin; the former including abnormal states caused by atmospheric influences, parasites, vegetable and animal, and poisons introduced into the body as such; the latter comprising primary perversions of general nutrition and diseases of the blood.

The infections are treated by Dr. Sims Woodhead. The article includes the bacteriology of the subject, in so far as its essentials are concerned, and bacteriological chemistry, a consideration of toxins, anti-toxins, immunity and, finally, a classification of the infective diseases met with in man, arranged according to their cause. The same author writes upon sapræmia, septicæmia and pyæmia. Dr. Hale White communicates a succinct article upon fever. He discusses the factors at work in the production of fever which differ from the physiological standpoint, and enters at some length into the parts played by increase of heat production and diminution of heat loss. According to him fever cannot, from the standpoint of its physiological cause, be regarded as an entity, the method of its production varying with the cause. The author concludes by indicating the methods which should be employed to reduce fever. Dr. Cayley contributes a full clinical monograph upon typhoid fever. The article is very carefully written, and, considering the space it covers (twenty odd pages), is very complete. It is interesting to note that the author considers "the evidence for the preventive action of the typhoid vaccine much stronger than that for the curative action of the serum," and recommends its trial "during epidemics and in persons, like nurses, who are especially exposed to infection."

Plague and cholera are dealt with by Dr. Cantlie. The author gives the results of Hafkine's inoculations in both these diseases. The articles upon dysentery, leprosy, malaria and several other tropical diseases are also written by Dr. Cantlie. The chapter on diphtheria is by Dr. Foord Caiger, and includes a most instructive table compiled from the total admissions into the Metropolitan Asylums Board hospitals of patients suffering from this disease. The table deals with a total of 25,000 cases, the ages of which vary from one year to sixty, and shows that while the average mortality of the whole is 24·7 per cent., the mortality in children between one and two years old is 50·2 per cent. The satisfactory results of the treatment of diphtheria by anti-toxic serum are evidenced by the dictum of the author "that a dose of from 2000 to 8000 units of anti-toxin should be given at the earliest moment in every case when the patient is a child." The articles on Rötheln, measles, scarlet fever and chicken-pox are from the pen of the same author.

Dr. Monckton Copeman supplies two monographs, upon small-pox and vaccinia respectively. In the article on small-pox reference is made to the work of Mr. Power concerning small-pox hospitals acting as a source of infection through the small-pox contagion being carried from them for a certain distance through the air. The importance of this fact cannot be over-estimated, and it is to be hoped that definite results, quantitative with regard to distance, will be obtained in this regard for other infectious diseases. The article on vaccinia includes extracts from the *Report* of the Royal Commission on Vaccination (1898), and also a consideration of the technique of vaccination.

In vol. ii. general diseases are continued. Dr. T. W. Shaw and Dr. James Cantlie contribute articles upon the diseases caused by parasites. Dr. Poore, conjointly with the editor, writes upon diseases determined by poisons introduced into the body as such—alcohol, morphine, cocaine, phosphorus and the ordinary metallic poisons being dealt with. Dr. Lazarus-Barlow contributes a general article upon inflammation and its sequels, and the editor one upon malignant disease. The possible parasitic origin of malignant growths is discussed shortly but adequately, and the references to the chief of the many exhaustive monographs upon this subject are given, a method, it may be noted in passing, which might have been advantageously adopted more frequently throughout the book. A short but interesting essay upon rickets is contributed by Dr. Coutts. The ætiology of this disease is only very shortly discussed; but it is instructive to note that the author directly contradicts the assertion that rickets never occurs in children fed entirely on mothers' milk. It is of the greatest possible importance to the public health to be quite clear upon this subject; the universality of rickets and the profound extent to which it affects the subsequent growth and activity of the various organs of the body is probably unsurpassed by any other morbific agency. Two articles upon diabetes mellitus and insipidus, respectively, are written by Dr. Bertrand Dawson. The article on gout is by Dr. Luff. In writing a short article presumably for students one

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must obviously be didactic. This method, however, has its limits; in this case we think these limits have been somewhat exceeded. The student, or even the practitioner, who does not supplement the knowledge of gout he has obtained from this source by some further reading will not, we are afraid, be in possession of the whole truth concerning this disease.

The remainder of the book is devoted to the diseases of the blood, the section being introduced by a chapter upon the blood under normal conditions, by Dr. Louis Jenner. This chapter will be found exceedingly useful to those interested in this subject; it is concise and up-to-date, and deals with the more generally employed technique. The diseases of the blood themselves are dealt with by Dr. Sidney Coupland.

In the case of the work before us, the reviewer finds himself in rather an anomalous position in that the editor has written no preface, so that it is difficult to know by what standard the book should be judged. From a careful perusal of it we should place it mid-way between a book of reference and an ordinary text-book of medicine. Had it contained fuller references to the literature it might almost have ranked as a reference-book; as it is, it will no doubt fill a very useful place, which it thoroughly deserves to do, in the library of the advanced medical student and the practitioner.

A NEW CLASSIFICATION OF THE REPTILES.

Beitrag zur Systematik und Genealogie der Reptilien. By Prof. Max Fürbringer. Pp. 91. (Jena: Fischer, 1900.) Price Mk. 2.50.

IN the year 1873 Prof. Fürbringer, who has quite recently succeeded his illustrious master in the chair of comparative anatomy at Heidelberg, commenced to publish a series of contributions to the morphology of the pectoral girdle of reptiles, with special reference to the myology, the fourth and concluding part of which has now appeared. This highly elaborate piece of work is supplemented by a chapter entitled "Beitrag zur Systematik und Genealogie der Reptilien," in which the author sets forth his views on the phylogenetic arrangement of the class Reptilia.

As regards the origin of reptiles, the numerous fossil remains with which we are already acquainted seem to indicate so complete a passage from the Stegocephalous Batrachians, that the question at issue has lately been where to draw the dividing line between the two classes, an uncertainty which is further emphasised by the fact that the Microsauria, such as *Hylonomus* and *Petrobates*, of Carboniferous age, placed by most authorities among the Stegocephala, are included in the Reptilia by Prof. Fürbringer. From a knowledge of these connecting forms the conclusion must, it seems, follow that the ancestors of the Reptilia proper, themselves probably derived from Crossopterygian Fishes, as believed by Cope, Baur, and many other modern zoologists, possessed a skull with numerous membrane bones roofing over the temporal and occipital regions and with an immovable quadrate, that they belonged, in fact, to the type designated by Cope as monimostylic. In the process of evolution, in the series known as the Squamata (lizards and snakes), the predominant modern reptilian type, the number of membrane bones having been reduced and the temple left more and more unprotected, the quadrate became free and more or less movably articulated to the squamosal and supratemporal (streptostylic skull of Cope). The direction of the line of evolution in this instance, running as it does concurrently with the reduction and disappearance of the limbs, seems clear enough, and it is further supported by geological data, all early Reptiles and Batrachians being monimostylic without a known exception, whilst the streptostylic types appear first in the Jurassic as Lacertilia, to be followed by Snakes in the Eocene.

These conclusions are, however, set aside by Prof. Fürbringer. For him, the streptostylic condition is the primitive one, and, from the partial homology which he believes to have established between the spheno-pterygo-quadrate muscle of the Lacertilia and the *tensor veli maxillae superioris* of Selachians, he is led to look upon the condition exhibited by Geckos and Monitors as nearer the original one than that known in *Sphenodon*, in which the said muscle is much reduced. From this sole consideration, and by the purely gratuitous assumption that some early Rhynchocephalians, such as *Kadaliosaurus*, and Microsaurians may eventually prove to have been streptostylic, the author thinks himself justified in holding that the ancestral types from which the Lacertilians have been derived cannot be sought for among either the Stegocephalians or the Rhynchocephalians with the cranial structure of which we are at present acquainted, but that they will be found to be connected with some primitive hypothetical Amphibian type in which the quadrate was movably articulated with the skull, as in the lowest form of living Selachians.

"That such primitive streptostylic Amphibians have once existed, is rendered probable by the facts ascertained in the ontogeny of the living Amphibians. Probably streptostyly became converted into monimostyly as, in the course of evolution, their originally superficial apparatus of dermal bones became more and more intimately connected with the quadrate, the mobility of which consequently lessened and finally completely ceased."

This reasoning, by which, on the ground of the imperfections of the geological record, chronological indications are absolutely ignored, is not likely to meet with general favour. After the multitude of well-preserved Carboniferous and Permian "Eotetrapoda" which have lately been discovered and described by Credner, Fritsch and others, it will be difficult to accept the author's teaching that we know practically nothing of the progenitors of existing reptiles, and that these must be connected through a series of hypothetical Proamphibia or Protetrapoda with equally hypothetical Selachian-like animals.

As a consequence of the above assumption, the new classification differs fundamentally from those hitherto based on phylogenetic considerations, in this, that the Streptostylia s. Squamata, with the two orders Lacertilia and Ophidia, are placed at the base of the series. The Rhynchocephalia, Acrosauria, Microsauria and Ichthyopterygia are associated with them in a subclass Tocosauria. A second subclass, Theromorpha s. Theromora, includes the Dicynodonts, Anomodonts and Pariasaurians; a third, Synaptosauria, the Mesosaurians, Sauropterygians

and Chelonians; whilst in a fourth, Archosauria, the Crocodilians, Dinosaurs and Pterodactyles are brought together. Little objection will be found to the composition of the second and fourth subclasses, as it answers to the views held by almost all modern classificators. But it is difficult to believe that the proposal to group the Squamata, Rhynchocephalia and Ichthyosauria in a group equivalent and opposed to the one including Mesosauria, Plesiosauria and Chelonia, will meet with ready acceptance. It would, however, carry us too far to enter on this occasion into a discussion of the reasons that have determined the author to adopt such an arrangement.

But it may not be out of place here to enter a protest against the introduction of new terms for higher divisions, such as Patagiosauria for the well-known Ornithosauria or Pterosauria, Gecko-Chamæleontes s. Uroplatimorpha for the group already named Uroplatoidea by Gill and Geccovarani by Cope, on the mere ground of the new names being more expressive. *À propos* of the last-named division, it is indeed startling to learn that the long-sought ancestor of the Chameleons is believed by Prof. Fürbringer to be approximated by the curious *Uroplates* of Madagascar which, formerly placed with the Geckos, was first raised to family rank on the ground of the difference in the shape of the clavicular arch. However, the arguments brought forward by the learned professor in favour of this hypothesis do not seem very convincing.

The limits assigned to this notice do not permit of attention being drawn to the many other salient points in the new classification, and to the incidental remarks on the relationships which birds and mammals bear to the reptiles. Suffice it to say that Prof. Fürbringer's work is, like everything we owe to his marvellous industry, most elaborate and careful, and that the very complete bibliographical indications that accompany it constitute in themselves a valuable mine of information for the student of the morphology and taxonomy of the reptiles.

G. A. B.

OUR BOOK SHELF.

A Practical Guide to Garden Plants. By John Weathers. Pp. 1192 + xii. (London: Longmans, Green and Co., 1901.) Price 21*s*. net.

THE garden plants here dealt with are those which are hardy enough to be cultivated in the open air, and they comprise not only ornamental plants but fruits and vegetables. A well-constructed glossary precedes the body of the work. The earlier portions are devoted to the life-history of cultivated plants, which is well done so far as it goes, but which would bear to be considerably expanded. It is rather misleading to call oxygen, carbon, hydrogen, nitrogen and the other elementary substances which the chemist finds in plants, different kinds of food. They are the materials of which food is made, but not the food itself.

The bulk of the work is made up of descriptions of the various hardy plants generally grown in gardens, together with indications for their cultivation.

The plants named are arranged in their natural orders, which is a great boon to the amateur, greatly facilitates the acquisition of knowledge, and adds to the interest of the plant. "If the cultivator," says the author, "has even only a slight knowledge of the way in which plants have been grouped more or less naturally by botanists, he may, by the aid of his books, run the unknown plant very close, if not quite, to its own group from the characters he sees. But if his books have the plants arranged simply in alphabetical order according to their names and not according to their relationships, he may as well give up his search at once unless he has the time and inclination to wade through every name from A to Z. Indeed, descriptive plant-books, arranged in purely alphabetical order, are only of value when the proper name of the plant about which information is required is already known."

From long experience we can confirm the author's statement. It is the fashion nowadays to neglect the comparative study of plants as they now exist, but, looking at the matter from a utilitarian point of view, it is of much greater use to be able to recognise the distinctions between one natural order and another than it is to indulge in speculative and conjectural genealogies. In any case, a knowledge, even though it be slight, of the principal natural orders adds greatly to the interest of a garden and often affords useful indications for cultivation. Mr. Weathers has sometimes supplied English names for the orders which appear to us as to be unnecessary—for instance, why should we have to learn that the Magnolia order is called the Lily-tree order, or why should the Leguminosæ be called the Laburnum and Broom order? The Latin names of the orders present, as a rule, little or no difficulty to those who really desire to know them. For those who do not, it is not necessary to put one's self to inconvenience. This portion of the work is excellent for reference purposes, and must have entailed great labour on the author.

The sections relating to fruit and vegetables are not so satisfactory, but, on the whole, the book is well calculated to satisfy the requirements of the amateur and of the professional gardener, the more so as it is provided with an excellent index.

Ausgewählte Methoden der Analytischen Chemie. By Prof. Dr. A. Classen. Erster Band. Pp. xx+940. (Brunswick: Vieweg und Sohn, 1901.)

THE first impression which this volume on select methods of analysis conveys is entirely favourable. The book is well printed, tastefully bound, and furnished with those delicate illustrations of apparatus which are characteristic of German chemical books.

The chief desideratum in a work on analysis is that the author shall not only be a skilled analyst, but that he shall have had personal experience of the methods which he describes.

Prof. Classen's connection with analytical chemistry, especially with the introduction of electrolytic methods, is too well known to leave any doubt as to his qualifications as an analyst, and we are assured by him in the preface that "In diesem Buche sind demnach diejenigen Methoden vorzugsweise beschrieben worden, welche ich persönlich vielfach anwandte, oder welche durch meine Assistenten und Schüler oder von dritten Seite kritisch geprüft wurden."

We can only admire the zeal and industry of the author and his assistants in having been able to examine critically even half the methods described in these 900 pages of closely printed matter. In reviewing a book of this kind, one naturally turns to the description of processes with which one is familiar. Judged by this test it fully justifies its first impressions. It is furnished with that minuteness of detail which is requisite in any book on quantitative and especially technical analysis, as this professes to be.

In addition to the estimation and separation of the commoner metals, considerable space is devoted to the rarer ones, some of which, like cerium and its allies, have recently entered the field of technical chemistry.

It seems odd that in a work relating entirely to metals

so little mention is made of metallurgical methods of assaying, which are frequently employed, not only for estimating silver and gold, but in the technical analysis of lead and copper ores. J. B. C.

Recueil de Données numériques. Optique. By H. Dufet. Part iii. Pp. 787–1313. (Paris: Gauthier-Villars, 1900.)

THE second part of this invaluable collection of physical and chemical data dealt with the optical properties of solids, and has already been described in these columns (vol. lx. p. 28). The present (and concluding) volume contains tables showing the rotatory powers of crystalline bodies, liquids and solutions, interference colours produced when rays of white light strike normally upon a layer of air of a given thickness, and supplementary tables of refractive indices, standard wavelengths, optical properties of inorganic and organic bodies, and other data. In all cases full reference is given to the authority for the values tabulated. The Physical Society of France has done a service to science by arranging for the preparation and publication of these results, which have been gathered from many sources, and are frequently difficult of access.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Apatite in Ceylon.

A PARAGRAPH in Prof. Miers' interesting notice (NATURE, March 7) of the results of Dr. Grünling's mineralogical expedition to Ceylon may convey the impression that Dr. Grünling was the first person to recognise, and Dr. Schiffer the first to analyse, the sky-blue apatite of Ceylon.

Now Mr. H. Willett, of Brighton, handed me several years ago a beautiful transparent specimen which I at once identified as apatite though its colour was unusual. The sky-blue, prismatically developed crystals were embedded in a white dolomitic matrix. This specimen had been brought from Ceylon by Mrs. Willett. Its exact provenance was unknown, but some spot not far from Kandy and the railway thither was suggested as the probable locality. There can be little doubt that this specimen came from the neighbourhood of Wattegama, between Kandy and Matale, where Dr. Grünling obtained the apatite analysed by Dr. Schiffer. In the *Mineralogical Magazine* for April 1899 (p. ix) will be found a notice of a paper read by me before the Mineralogical Society on January 31, 1899, just two years ago, entitled "Analyses of Ceylon Apatite." Following this title occurs the paragraph: "Prof. Church exhibited blue apatites from Ceylon, one containing as much as 3·21 per cent. of chlorine, others only 0·63 and 0·34 per cent." The last of these three figures represents the percentage of chlorine found by me in Mr. Willett's specimen.

In discussing, in the autumn of 1898, the question of Ceylon apatite with Prof. Judd and Mr. F. W. Rudler, I found that the identification of this mineral did not seem at that time to have been published. Prof. Judd was good enough to supply me with specimens from another Ceylon locality (near Newara Eliya) and having a different matrix. Here the colour of the apatite was paler and its crystalline habit indistinct. This sample gave 0·63 per cent. of chlorine.

But by far the most interesting specimens were some imperfect tabular crystals sent to me in 1898 by a gem-merchant of Colombo. These were of a much richer blue colour than any of the other examples. Indeed, my Colombo friend's attention had been drawn to them by one of his "Moormen" having brought to him, some time previously, a perfectly transparent cut gem weighing five carats, which he offered as a blue spinel! I wrote for uncut specimens, which were soon procured from the same Moorman, but he had removed them from the matrix. The locality of these specimens proved to be Avisavelle. One of these crystals it was that gave me 3·21 as the percentage of chlorine. I may add that the dichroism of this variety closely resembled that of vivianite.

I would remark in conclusion that the number of Dr. Groth's *Zeitschrift für Krystallographie u. Mineralogie* in which the blue apatite of Ceylon is described was published last year, long after the notice of my paper had appeared in the *Mineralogical Magazine*. If any earlier communication on the subject has appeared I should welcome a reference to it.

A. H. CHURCH.

Maps in Theory and Practice.

EVERY advanced treatise on astronomy defines and explains certain kinds of map projection; but in all these accounts I have been struck with the absence of any notice of the particular kind of projection with which we are most familiar—the kind usually employed for representing the world in hemispheres; in fact, the commonest kind of map projection.

I have for the first time come across a notice of it, at p. 126 of the February number of the *American Journal of Science*, in the following terms:—

"The method of projection almost universally employed by geographers for representing hemispherical surfaces is the so-called globular projection, invented in 1660 by the Italian Nicolosi (Germain, 'Traité de Projections des Cartes Géographiques,' Paris, about 1865). The equator is divided into equal parts, and the meridians are circular arcs uniting these points with the poles. The parallels are likewise circular arcs, dividing the extreme and central meridians into equal parts."

As three points suffice for determining a circle, this definition is complete for the mapping of a hemisphere extending from pole to pole. To apply it to a smaller portion of the earth's surface, let the hemisphere be so taken that this portion is centrally placed between east and west; then the central meridian will be straight.

As it is desirable that theory should be kept in touch with practice, I would commend this subject to the attention of teachers of geography and astronomy. J. D. EVERETT.

11 Leopold Road, Ealing, W., March 11.

Early Observations of Volcanic Phenomena in Auvergne and Ireland.

MR. G. P. SCROPE ("Extinct Volcanos of Central France," ed. 2, 1858, p. 30) describes how Guettard and Malesherbes, returning from Italy, met Faujas de St. Fond at Montélimar in 1751, and, in his company, founded the theory of the volcanic origin of the mountains in the Vivarais. Guettard and Malesherbes thence proceeded to Auvergne, where M. Ozy, a chemist of Clermont-Ferrand, acted as their guide. Ozy knew his ground well, and had already observed the general aspect of the rocks, since Guettard (Mém. Acad. roy. des Sciences, 1752, p. 37) says that he "m'assura . . . que je trouverois par-tout une même structure & les mêmes matières qu'il m'avoua ingénument n'avoir jamais reconnues pour ce qu'elles étoient."

Sir A. Geikie has justly written of the discoveries of Guettard ("Anc. volcanoes of Gt. Britain," preface), "To France, which has led the way in so many departments of human inquiry, belongs the merit of having laid the foundations of the systematic study of ancient volcanoes."

Considerable interest, therefore, attaches to a letter from Ozy, published by Faujas de St. Fond in 1778 ("Recherches sur les volcans éteints du Vivarais," p. 434), and written in reply to inquiries as to what authors had first visited the volcanoes of Auvergne. Ozy refers somewhat casually to his meeting with Guettard, which was already well known through the information provided by him, and fully acknowledged in Guettard's paper. But he states that a year before, that is, in 1750, he was visited by "Olzendorff," an Englishman, and "M. Bowls, irlandois," who came to inspect the adjacent lead-mines. He continues: "Nous montâmes ensemble au *Puy de Dome*, & ce fut là que j'appris pour la premiere fois à connoître les *cratères*, les laves, &c., car auparavant je n'étois pas plus instruit sur cet objet que les autres habitans de cette province."

It seems hardly possible to construe this passage, written in answer to a direct inquiry from St. Fond, into a confusion of the two ascents. The "ensemble" refers to Olzendorff and Bowls; "la premiere fois" can hardly refer to events of the subsequent year. "Bowls," moreover, was, with high probability, William Bowles the mineralogist, who is known to have

been born in Cork, and who published his work on the natural history of Spain in Paris in 1776. It would be very interesting to trace any conclusions as to extinct volcanoes that were current in Bowles's mind as early as 1750. Ozy is not likely to have made a show of his previous knowledge to men of established position like Guettard and Malesherbes, who had honoured the local apothecary with a call. He listened to their exposition of the craters, and "avoua ingénument" that he was much surprised at what he heard. After all, it was Guettard who took the matter up absolutely fresh from the beginning, and whose memoir made it for the first time public knowledge.

Bowles may have come from Catalonia, and may have formed his opinions there. I make no mention of Olzendorff, of whom I have no further trace; but the fact that Bowles instructed Ozy at Clermont, if the above contention is correct, a year before Guettard had formed his conclusions, and in an age rife with unfounded speculation, marks him as a geological observer deserving of more credit than he has yet received. I called attention to Ozy's letter in *Knowledge* for 1898, p. 266, and have since made inquiries through friends in Cork and elsewhere; but the present family of Bowles in Cork, formerly Boles, can furnish no data as to the life of the mineralogist.

An interesting inquiry also arises as to when the Giant's Causeway in Antrim was first regarded as a lava-flow. What did Bowles know of this phenomenon? Its detailed appreciation, from a geological point of view, is usually ascribed to Whitehurst, in the second edition of his work in 1786. But Faujas de St. Fond in 1778 calls many of the French lava-flows "chaussées," and clearly shows his own conclusions when he styles certain examples with good columnar jointing "pavés des géans."

GRENVILLE A. J. COLE.

Royal College of Science for Ireland, Dublin, March 1.

Probability—James Bernoulli's Theorem.

IT may possibly be of some little interest to notice that the theorem in probability, which goes by the name of James Bernoulli's theorem, alluded to in my letter to NATURE of December 13, 1900 (p. 154), admits of a treatment somewhat more elementary than the usual one.

The theorem may be stated thus:—If p is the probability of a given event, and n the number of times considered; as n increases without limit, the probability that the ratio of the number of times in which the event happens to the whole number of times (n) will only deviate from p within limits of excess and defect, which decrease indefinitely as n increases without limit, is a probability which approaches indefinitely to unity as its limit.

In Laplace's demonstration (see Todhunter's "History of Probability," art. 993) Stirling's theorem, for the evaluation of factorials, is used in the first step; in the second step the theorem of Euler,

$$\Sigma y = \int y\,dr - \tfrac{1}{2}y + \tfrac{1}{12}\frac{dy}{dr} - \dots$$

which is also implied in the usual proof of Stirling's theorem; and, finally, the result depends on the evaluation of the well-known definite integral $\int_0^\tau e^{-t^2}dt$.

Further, it is essential to this demonstration to make the limit of deviation in excess from the ratio p equal to the limit of deviation in defect, for then as members of the series, which represent the probability sought, equidistant from the middle of the series contain certain terms equal in magnitude and of contrary sign, these terms cancel in the addition of such pairs, and are thus got rid of.

It may be shown that the general result of Bernoulli's theorem may be got without the above described use of Euler's theorem (*i.e.* the second use of it), without using the evaluation of $\int_0^\tau e^{-t^2}dt$, and without making the limits of excess and defect equal. These limits may have any ratio whatever.

Let q be the probability that the event does not happen, so that $p+q=1$.

Let the whole number of times considered be $y+x$. Since this is to increase without limit, we may suppose $p(x+y)$ and $q(x+y)$ always integers.

Let P be the probability that the number of the times in which the event happens be between $p(x+y)+ax$ and $p(x+y)-bx$ where $(a+b)=1$, so that x represents (so to speak) the range of the variation, a and b may have any ratio to one another. Assume that $y=mx^{2(1-\kappa)}$, where κ may be as small as we please, but finite. Thus P is the probability that the ratio of the times when the event happens to the whole number of times shall not exceed p by more than $\frac{ax}{x+y}$, or fall short of p by more than $\frac{bx}{x+y}$; limits which vanish when x and y are infinite.

Let P_1 = probability that the number of times in which the event happens is less than $p(x+y)-bx$, and P_2 the probability that it exceeds $p(x+y)+ax$. Then $1-P=P_1+P_2$.

$$P_1 = p^{x+y} + (x+y)p^{x+y-1}q + \dots + \frac{(x+y)!\; p^{p(x+y)+ax+1}q^{q(x+y)-ax-1}}{\{p(x+y)+ax+1\}!\;\{q(x+y)-ax-1\}!}.$$

Now P_2 evidently = the probability that the number of cases in which the event does not happen is less than $q(x+y)-ax$, and therefore the series for P_2 is derivable from that for P_1, by interchanging p and q, and by interchanging a and b. These values of P_1 and P_2 may, of course, be also got from the equation

$$P_1+P_2=(p+q)^n-P.$$

P_1 is evidently less than the geometrical progression of which the sum is

$$\frac{(x+y)!\; p^{p(x+y)+ax}q^{q(x+y)-ax}}{\{p(x+y)+ax\}!\;\{q(x+y)-ax\}!}\cdot\frac{\left\{\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}\right\}^{q(x+y)-ax+1}-1}{\frac{p}{q}\,\frac{q(x+y)-ax}{p(x+y)+ax+1}-1}$$

By Stirling's theorem, x and y increasing *ad. inf.*

$$(x+y)! = (x+y)^{x+y+\frac{1}{2}}e^{-(x+y)}\sqrt{2\pi}\left(1+\frac{1}{12(x+y)}+\dots\right)$$

$$= y^{x+y+\frac{1}{2}}\left(1+\frac{x}{y}\right)^{x+y+\frac{1}{2}}e^{-(x+y)}\sqrt{2\pi}\left(1+\frac{1}{12(x+y)}+\dots\right),$$

and similarly for the other factorials.

Thus the above expression becomes

$$\frac{1}{\sqrt{2\pi pq}}\cdot\frac{\left(\frac{1}{12(x+y)}+\dots\right)}{\left(1+\frac{1}{12(p(x+y)+ax)}+\dots\right)\left(1+\frac{1}{12(q(x+y)-ax)}+\dots\right)}\cdot$$

$$\frac{\left(1+\frac{x}{y}\right)^{x+y+\frac{1}{2}}}{\left(1+\frac{(a+p)x}{py}\right)^{p(x+y)+ax+\frac{1}{2}}\left(1+\frac{(q-a)x}{qy}\right)^{q(x+y)-ax+\frac{1}{2}}}\cdot\frac{1}{y^{\frac{1}{2}}}\cdot$$

$$\frac{\left\{\frac{p}{q}\,\frac{q(x+y)-ax}{p(x+y)+ax+1}\right\}^{q(x+y)-ax+1}-1}{\frac{p}{q}\,\frac{q(x+y)-ax}{p(x+y)+ax+1}-1}.$$

The limit of the second factor is unity. The third factor may be shown to become in the limit

$$\frac{1}{e^{\frac{a^2}{2mpq}}}x^{2\kappa}.$$

The limit of

$$\left\{\frac{p}{q}\,\frac{q(x+y)-ax}{p(x+y)+ax+1}\right\}^{q(x+y)-ax+1}$$

is the limit of e^{-cx}, and the limit of

$$y^{\frac{1}{2}}\left(\frac{p}{q}\cdot\frac{q(x+y)-ax}{p(x+y)+ax+1}-1\right)=-hx^{\kappa},$$

where c and h are positive constants. Hence the limit of the product of the factors is zero—that is, the limit of P_1 is zero, and evidently also the limit of P_2.

Hence the limit of P is unity.

The range of the deviation (x) is greater in this proof than in the usual one, for in the latter x would vary as $y^{\frac{1}{2}}$ as against $y^{\frac{1}{2-2\kappa}}$ where κ may be as small as we please.

A further simplification would be introduced by a method of evaluating the series P_1 or P_2 without the use of Stirling's theorem. Such a method has been given me by Mr. G. G. Berry, of Balliol College, and may be briefly described as follows:—

If in the expansion of $(p+q)^n$ we stop t terms before the greatest, the truncated series has a smaller sum than the G.P., which has the same two final terms. If t^2 is great as compared with n, the G.P. has a sum which vanishes compared with its final term multiplied by $\sqrt{n}$. But the product of the greatest term of $(p+q)^n$ and $\sqrt{n}$ is finite; for the sum of $\sqrt{n}$ terms on either side of the greatest <1, and the ratio of the greatest term to a term distant from it by $\sqrt{n}$ places is—

$$\frac{\left(1-\frac{1}{pn}\right)\left(1-\frac{2}{pn}\right)\cdots\left(1-\frac{\sqrt{n}-1}{pn}\right)}{\left(1+\frac{1}{qn}\right)\left(1+\frac{2}{qn}\right)\cdots\left(1+\frac{\sqrt{n}}{qn}\right)},$$

which has a finite limit. J. COOK WILSON.

Oxford.

A Tree Torn by Lightning.

I ENCLOSE two photographs of an oak tree struck by lightning, which seem of interest.

The storm, one of considerable violence, occurred on July 27, 1900, and continued for several hours. The tree stood by the side of a road which runs over the Chilterns from Ipsden, a little village about five miles from Wallingford and ten from Henley. It was standing at the western edge of a small stretch of woodland. The opposite side of the road was quite clear and sloped down to the plain.

FIG. 1.

On examination, the bark was found to be completely stripped off and flung on one side; a large branch was torn away, and the fractured end was extraordinarily splintered and smashed. So far as I saw there were no signs of charring.

The inner surface of the bark was marked longitudinally with thin wavy lines, very close-set, of which the crests were about ¼ inch apart.

The first photograph gives a general view of the tree; the second represents the lower side of the bent portion of the trunk, and shows very clearly the rending effect of the lightning on a fibrous tissue.

FIG. 2.

The photographs were taken about a fortnight after the tree was struck, during which time there had been much wind and rain. PERCY E. SPIELMANN.

Adaptation of Instinct in a Trap-door Spider.

THE following extract from the *Sydney Bulletin*, January 12, sent to me by a correspondent in Western Australia, recounts an observation sufficiently interesting, I think, to be reprinted and put on permanent record in a scientific periodical:—"A friend of mine noticed near his camp a trap-door spider run in front of him and pop into its hole, pulling the 'lid' down as it disappeared. The lid seemed so neat and perfect a circle that the man stooped to examine it, and found, to his astonishment, that it was a sixpence! There was nothing but silk thread covering the top of the coin, but underneath mud and silk thread were coated on and shaped convex (as usual). The coin had probably been swept out of the tent with rubbish."

As is well known, the doors of trap-door spiders' burrows are typically made of flattened pellets of earth stuck together with silk or other adhesive material. The unique behaviour of the spider in question showed no little discrimination on her part touching the suitability as to size, shape and weight of the object selected to fulfil the purpose for which the sixpence was used. R. I. POCOCK.

March 6.

Protective Markings in Cats.

IT will probably appear to many—as it does to myself—that the development of a protective mechanism in a domestic animal is not likely, and for several reasons—such as the shortness of time at the disposal of the race, and, of course, to their large independence of stress of circumstances. Still it may be admitted that the domestic cat bears its subjugation to man more lightly than many of the other creatures which he has tamed. The particular mark above the eye to which your correspondent refers (p. 441) has also been pointed out by Mr. Wallace in the dog. It may interest those of your readers who are not aware of the fact to learn that the tiger has a largish and very bright white spot upon the back of the ear. When the ears are directed forwards this spot is exceedingly conspicuous from in front (as any one may verify upon the fine pair of tigers now in these gardens); and, in the dimness of a cave or a thicket, might conceivably produce an impression of alertness when the animal was really sleeping.

Zoological Society's Gardens. FRANK E. BEDDARD.

FURTHER OBSERVATIONS ON NOVA PERSEI.[1]

SINCE the preliminary note on this star was communicated to the Royal Society on February 28, observations have been possible on the nights of February 28, March 1, 3 and 5, and twenty-four photographs of the spectrum have been taken with the instruments before detailed.

It may be stated generally that the light is slowly waning. On February 28 the star was only slightly brighter than α Persei. On March 1 it was estimated as about equal to α Persei, *i.e.* about 2·0 magnitude. When it was again visible, on the evening of March 3, it was distinctly less bright than β Persei, and its magnitude probably near 2·5. On the 5th its estimated magnitude was 2·7.

The above refers to the visual brightness. A photograph of the region occupied by the Nova on March 3 showed it to be photographically brighter than α Persei.

General Description of the Spectrum.

The photographs show that the bright hydrogen lines are successively feebler as the ultra-violet is approached, and the whole of the series of hydrogen lines have, during the past week, become relatively brighter with respect to the remaining lines and the continuous spectrum. The spectrum extends far into the ultra-violet.

Among the changes which have taken place in the visible part of the spectrum, it may be mentioned that, while the lines of hydrogen have become relatively brighter during the past week, the remaining lines, with the possible exception of the prominent one at λ 5169, have become distinctly dimmer. There has also been a diminution of the intensity of the continuous spectrum. The line in the yellow, the identity of which has not yet been definitely determined, has gradually decreased in intensity with the diminution of brightness of the star. The bright green-blue F line of hydrogen has become more conspicuous as the neighbouring green lines have become fainter, and the bright C line is intensely brilliant.

From all these causes, which give us blue light on the one hand and red on the other, the star should present to us the precise quality of red which has been observed.

Colour.

At discovery the star was described as bluish-white. No observations on its variation in hue during its brightening were possible, owing to unfavourable weather conditions. The observations during the period of decline have indicated a change to the present colour of a decided claret-red. In comparison with this it is interesting to note that in the case of the Nova which appeared in 1604, Kepler alludes to purple and red tints assumed by the star.

Changes in the Photographic Spectrum.

Between February 25 and March 5, to take the extreme difference of dates on which photographs were obtained, it has been noted that while some of the dark lines were absent on the later date, either new lines had come in or previously feeble lines had become intensified. There has not yet been time to determine accurately the positions of these lines. The appearance of the bright lines of hydrogen, which I described as being reversed on February 25, had very materially changed by March 3.

In inspecting the dark band representing the bright hydrogen at Hϵ, two darker fine lines are seen nearly coincident in position with the edges of Hϵ in the spectrum of α Persei photographed on the same plate.

The appearance in the case of the "F" line (Hβ), is seen by the accompanying light curve (Fig. 1).

[1] Abridged from a paper read at the Royal Society on March 7, by Sir Norman Lockyer, K.C.B., F.R.S.

No doubt the differences in the appearances are due to a fact that at Hϵ we are dealing with the lines both of H and Ca.

Rough measurements on the bright line Hβ show that the interval between the centres of the two extreme maxima shown in the light curve corresponds to about 25 tenth-metres. This would give a differential velocity of 960 miles per second between the different sets of hydrogen atoms in the bright line swarm itself.

It may be, then, that the appearances described as reversals of the hydrogen lines on February 25 were but the beginning of the subsequent changes.

The comparisons with stars which have been taken with the slit-spectroscope on each evening of observation, indicate that no great change in the velocity of the dark line component has occurred. So much, however, cannot

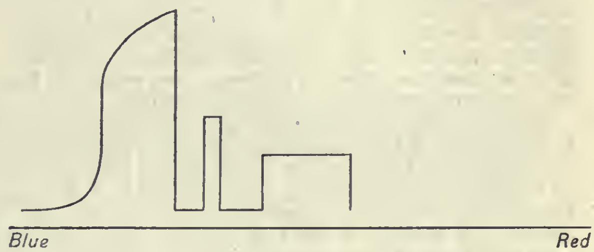


FIG. 1.

be said of the bright lines in which a change has been observed.

In addition to the hydrogen lines, the strong lines in the green already ascribed to iron appear to be double in the photographs most recently obtained.

Comparison with α Cygni.

The view of the apparent similarity between the spectra of Nova Persei and Nova Aurigæ, to which I drew attention in my previous paper, has been strengthened by the comparisons which have since been made.

The bright lines in the spectrum of Nova Persei are so broad, especially in the blue and violet, that accurate determinations of their wave-lengths are difficult to obtain. The lines less refrangible than F, however, besides being more isolated, are narrower than those in the more refrangible part of the spectrum. A direct comparison of these with the lines in the spectrum of a star which is known to contain the enhanced lines of iron, &c., has been considered a better method of arriving at some definite conclusion as to the connection between the Nova lines and the enhanced lines than that of determining the wave-lengths of the broad lines and comparing the results with the known wave-lengths of the enhanced lines.

The best star for this purpose is α Cygni, but, unfortunately, no good photograph has been obtained at Kensington of the green portion of the spectrum of that star. The star most nearly approaching α Cygni in relation to enhanced lines is α Canis Majoris, which, in the Kensington classification, has been placed nearly on a level with the former star, but on the descending side of the temperature curve. In the spectrum of this star the enhanced lines of iron at $\lambda\lambda$ 4924·1, 5018·6, $\begin{cases} 5169·0, \\ 5169·2 \end{cases}$ and 5316·9 occur as well-marked lines. This spectrum has been directly compared with that of Nova Persei, taken with the same instrument, and the fact that all the lines apparently coincide affords good evidence that the connection is a real one, and that the first four strong Nova lines beyond F on the less refrangible side are the representatives of the enhanced lines of iron. These are the only enhanced lines which occur in that part of

the iron spectrum, with the exception of a weak one at λ 5276. There is only a trace of this line in the spectra of either the Nova or α Canis Majoris which have been compared. In the spectra of the Nova obtained with lower dispersion, however, a line is distinctly shown in this position, though it is considerably weaker than the four lines previously mentioned.

The absence of the strong lines which are familiar in the arc spectrum and in the ordinary spark spectrum in this region is to be ascribed to higher temperature; experiments which are in progress show that under certain conditions the two lines λλ 5018·6 and 5169 are by far the strongest lines in the spectrum of iron between λ 500 and D, while that at λ 4924·1 is distinctly stronger than any of the well-known group of four arc lines in which it falls.

The published wave-lengths of the lines of Nova Aurigæ show that the same lines were present in that star. Further investigations of the spectrum of Nova Aurigæ have strengthened the conclusion that most of the lines, after we pass from those of hydrogen, are enhanced lines of a comparatively small number of metals.

When the inquiry is extended into the regions more refrangible than Hβ, the evidence in favour of the similarity of the spectra of the two Novæ with that of α Cygni is not so conclusive, because of the greater breadth of the lines (since the spectra have been obtained by the use of prisms) and because of the fact that in this region the enhanced lines of iron frequently occur in groups.

In the region between Hδ and Hγ, however, there is a well-marked enhanced line of iron at λ 4233·3, and also two doubles at λλ 4173·7, 4179·0, and λλ 4296·7, 4303·3, and a comparison of α Cygni with Nova Persei indicates that these fall on broad bright bands of the Nova spectrum.

NORMAN LOCKYER.

MR. BORCHGREVINK'S ANTARCTIC EXPEDITION.[1]

MR. BORCHGREVINK succeeded in an enterprise of which he may be justly proud. Unknown and without external influence, by the force of his immense ambition and determination, he obtained the support of a man of great wealth, and unaided, if also untrammelled, by Government, learned societies or committees of any kind, he equipped an expedition, selected a scientific staff, spent a winter on land in the Antarctic regions for the first time in history, and made his way to a point nearer the South Pole than had ever been reached before. For doing this he deserves praise and honour. With his motives we have no concern; they appear to have been partly commercial and partly scientific, but in these columns we can only treat the expedition from a purely scientific point of view, forming our opinions from the facts placed before us in the book.

Mr. Borchgrevink chose his ship well, and she proved to be as stout and powerful a steam-whaler as ever put out from Norway. He chose his scientific staff well, and they appear to have worked conscientiously and to have obtained results which cannot fail to advance knowledge if they are properly discussed and published. He chose his sailing master, Captain Jansen, well, and he appears to have conducted the expedition without a hitch or any trace of insubordination. Mr. Borchgrevink was able to repeat in his steamer Sir James Clark Ross's sailing-ship voyage, and saw again Mounts Erebus and Terror; he landed on the southern ice, and advanced a few miles beyond the edge of the previously known world.

The book is short—an excellent thing in accounts of travel; the author has a certain power of observation and description, as the chapter on the habits of penguins and many little episodes of personal adventure show. His illustrations are remarkably fine, admirable reproductions of good photographs, and they are introduced with a lavish hand.

This is the bright side of the medal; the reverse is not so pleasing. Mr. Borchgrevink would have done better if he had had another chronicler, for his literary style does him less than justice. We can excuse an author, whose forte is action rather than study, for attributing incorrect titles to English men of science, but he might surely be expected to give correctly the names of his own distinguished countrymen, amongst whom Dr. Hjort appears as *Hjorth*, and Dr. Reusch in one place as *Reush* and in another as *Rusch*. Although the book is small we can hardly attribute these slips to anything but haste in correcting the proofs. We wish we could find an equally satisfactory explanation of other errors of a more serious kind.

We fear that Mr. Borchgrevink did not set his ambition high enough, and did not endeavour to make himself acquainted with the elementary principles of the various sciences which the members of his staff were pursuing. During the long Antarctic night he might easily have learned from his skilled assistants more than sufficient to have enabled him to give an intelligible sketch of the work of his expedition, even if time had been wanting at an earlier period. That he did not do so is to be inferred from the following circumstances, to which we call attention with real regret and which we would have passed over gladly were it not that the objects of the expedition have been generally spoken of as scientific.

On p. 63 there is given what purports to be a fully worked example of the calculation of the longitude from observations of the sun taken near Balleny Island,[1] by means of a Cary 10-inch sextant. The index error was found to be "14 in." off the arc—a possible printer's error for 14″, one would think; but further down the error is given as 14′ 0″. However, the sun's semidiameter is also estimated at the excessive value of 16° 17′ 1″, and this gives us a clue to the system of notation employed for the corrections, though not for the instrumental reading. It is simply to write minutes as degrees, seconds as minutes and decimals of a second as seconds. Working out the calculation on this assumption the final corrected altitude is obtained as stated. On p. 64 the curious blunder of "Lysin Sq.," probably intended for "Log Sin²," and several others equally absurd have escaped the author's vigilance, and the logarithms set down are not what we would expect.

Is this an elaborate joke played by the author on the public, or is it a joke played on the author by some person unknown and not detected by him? We cannot think that it was meant seriously, and we cannot see why the example was ever given, as no one has any interest in disputing the position of Balleny Island. The actual figures and working of the really critical observation which convinced Mr. Borchgrevink that he had got further south than Sir James Ross might have been quoted reasonably enough, but are not. If any credence is to be given to the position of the expedition at any date, the serious question raised by this worked specimen must be answered.

On p. 136 we read, "Only Jupiter and its stars and Centauri were visible." So much for astronomy.

With regard to meteorology the same indifference to figures occurs. In more than one place the height of the barometer is given in the form "29.7.1," although elsewhere the readings are expressed in the usual way. The vaguest references are made to instrumental observations; for instance, a graphic account is given of the difficulty of placing a thermograph at 2000 feet on Cape

[1] "First on the Antarctic Continent; being an account of the British Antarctic Expedition, 1898–1900." By C. E. Borchgrevink, F.R.G.S., Commander of the Expedition. With portraits, maps, and 186 illustrations. Pp. xvi+334. (London: George Newnes, Ltd., 1901.)

[1] Balleny Island is stated, on p. 3, to be a volcano 12,000 feet high; here there is evidently some confusion with Mount Erebus.

Adare, and of returning for it a week later; but its readings are not noted. The "anti-cyclonic theory" is referred to, but neither discussed nor explained.

"Characteristic stratification of the rocks" is referred to on p. 223, and some of the photographs do appear to show lines of bedding; but we are left in doubt as to whether the author realises the great interest of discovering such rocks on the Antarctic continent. In the preliminary report on the rock-specimens by Mr. J. T. Prior, in the appendix, there is no reference to anything most like stratified rocks than a "pale green slate and quartz grit," of which no particulars are given. On p. 264 we read of "a huge cauldron, the bottom of which was even below the sea-level, but guarded against the waters of the cove to the west by a narrow ridge of brimstone"; but this unusual structure does not seem to have been investigated.

As to biology, birds are always referred to by their full names, generic and specific; but the seals are simply termed "Weddelli" (a name used to distinguish this seal from the sea-leopard) or "Rossii," as the case may be, without indication of their genera. Biological theory is handled thus in speaking of what is called "bi-polarity" (p. 232).

"The existence of organisms does not develop from the presence of the possibility of existence for these, but because the element necessary for the development of these organisms was brought into conditions which favoured its development into a complete organism. It seems thus that the fount whence the element of these organisms rises exists both within the Arctic and Antarctic Circles, apparently without any communication through the intermediary zones."

In dealing with geography there is an equal want of sense of proportion, definite information or clear ideas. The description of the coast of Victorialand is far less definite than Ross's. No connected account is given of the land-explorations which were carried out near Cape Adare. Mr. Borchgrevink states that he was away from his camp for so many days or weeks, but gives the vaguest descriptions of where he went or what he saw. As he climbed a glacier on one occasion—"step by step we rose until we were a few thousand feet up, as indicated by the aneroid." This is offering a stone to the reader who hungers after definite information. The log of the crossing of the pack by the *Southern Cross* on four separate occasions might be expected to yield most important hints to the forthcoming Antarctic expeditions; but details are only given of one of these crossings. The description of the southern ice-barrier, which was dismissed in a few lines by Mr. Borchgrevink in his paper to the Royal Geographical Society, was looked forward to with the keenest interest; but in this matter we find the most tantalising reticence. The famous ice-barrier, we are told, is only from 60 to 70 feet high (about one-third of the height assigned by Ross), and at the point where a landing was made it was only 2 or 3 feet, and rose gradually southward to the normal height. There is no information as to the depth of the water alongside the barrier, a point of the most vital moment. One sounding does, indeed, figure on the map, but the exact point to which it applies is not indicated. The remarkable fact that the position of the ice-barrier was found to be many miles further south than reported by Ross is not commented on. A long digression on icebergs and pack-ice is interposed in the middle of the twelve lines of description given to the part of the world where no one had ever been before. It concludes, "With a sufficient number of reindeer, sledges and dogs, and a very small party of scientific men, I believe that a great southern latitude may be reached on this ice-sheet in the proper longitude," but never a word as to what the proper longitude is.

FIG. 1.—A Crystal Palace. From "First on the Antarctic Continent." By C. E. Borchgrevink.

On pp. 270–71 we read, "We secured valuable photos. of Mounts Erebus and Terror, the former being in activity;" but will it be believed that these "valuable photos" are not reproduced? This is, we confess, the most staggering circumstance about the book. Dozens of excellent pictures are given which possess absolutely no scientific value, but the one which, of all others, the

geographer and geologist would like to examine has been kept back although it turned out a success.

The publication of his book will, we fear, tend to detract from the reputation which Mr. Borchgrevink has unquestionably merited by his organising power, his invincible perseverance and his successful completion of a considerable task. Had he been content to leave the the discussion of matters which he did not understand to the skilled members of his staff, and had he encouraged them to discuss and describe their observations, his expedition would have redounded to his credit in scientific circles, as well as amongst lovers of adventure. We believe that the extensive collections are being examined and described by specialists in the British Museum; and we hope that the magnetic and meteorological work will also be discussed by experts and published in detail. Some results in an unreduced form are given in the appendix, the most important being Mr. Louis Bernacchi's excellent summary of the meteorological and magnetic observations, which is somewhat fuller than that published previously in the *Geographical Journal.*

It is painful to us to be obliged to touch on the limitations of a strong and courageous explorer, but we cannot pass by without protest so striking an instance of the inability of an unscientific chief to appreciate the nature of the problems which his scientific subordinates are investigating or the results they obtain.

THE TOTAL ECLIPSE OF THE SUN, MAY 18, 1901.

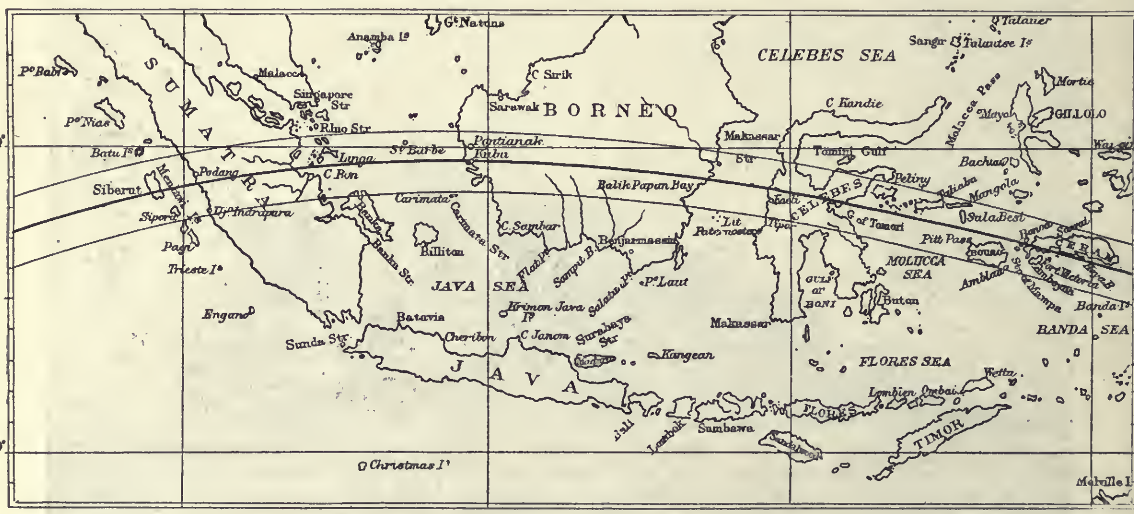
The approaching total eclipse of the sun is a notable one, not only on account of the unusually long duration of totality at the most favoured stations, but also because it occurs very near a time of minimum sun-spots. An exceptionally good opportunity of studying the corona at an important phase of the solar period is thus afforded, provided always that the sky is unclouded at the critical times.

The shadow strikes the earth a little to the south-west of Madagascar, traverses a north-easterly path across the Indian Ocean, passing over Mauritius and entering Sumatra near Padang, continues eastward across the southern part of Borneo, deviates to the south-east through the Celebes and the southern part of New Guinea, and leaves the earth in long. 156° 58′ E., lat. 12° 50′ S. (See accompanying map.)

While the weather prospects at most of the possible stations of observation are, unfortunately, not of the best, there is sufficient encouragement in the meteorological statistics to hope that records of the phenomena will be secured at at least one place.

In Mauritius, in the neighbourhood of the Royal Alfred Observatory, where the duration of totality is 3m. 35s., the chances of fine weather at eclipse time are very hopeful. Mr. Claxton, the director of the Observatory, states that on only two occasions since 1874 has the sky been overcast at 9 a.m. on May 18, on sixteen occasions it has been less than half covered, and on nine occasions practically cloudless (*Journal* of the Brit. Ast. Assoc., vol. xi. p. 121).

In the Malay Archipelago, where the maximum duration of totality on the central line is nearly 6½ minutes, the weather prospects are not quite so good. At Padang, on the west coast of Sumatra, which is one of the most accessible and otherwise most suitable stations, the percentage clearness during May is only 28, as against 50 per cent. for the Makassar Strait between Borneo and Celebes (NATURE, vol. lxiii. p. 163).



Part of the path of the moon's shadow during the total solar eclipse of May 17–18, 1901. Reproduce from the *Nautical Almanac Circular*, No. 18.

In these circumstances, it seems particularly desirable that the observers should be as widely distributed as possible, so as to diminish the risk of total failure to secure observations. This multiplication of stations, however, is rendered impracticable in this instance by the comparatively small number of astronomers at liberty to undertake the long voyage involved, and to some extent also by other causes, not among the least forcible being the undesirable presence of savage races at some places near the central line.

Arrangements have been made by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies to attempt to secure observations at Padang and Mauritius. At the former station will be Mr. Newall and Mr. Dyson, who will be joined by Mr. Atkinson as a volunteer, and at the latter Mr. Maunder will work in conjunction with Mr. Claxton. While it is to be regretted that other British observers of experience do not find themselves in a position to join the expeditions, there is consolation in the fact that parties from other countries have arranged to make observations. We understand that Holland will be represented by an expedition under Dr. Nyland, of Utrecht, who will be

accompanied by W. H. Julius and W. H. Wilterdinck, of Leiden, and will probably make Padang his headquarters. Somewhere in the neighbourhood of Padang, also, the American astronomers, Prof. Barnard and Prof. Todd, together with a party from the Washington Observatory, and another party from the Lick Observatory, are expected to set up their instruments. Prof. Campbell has selected Mr. C. D. Perrine to take charge of the expedition from the Lick Observatory, and this observer will be accompanied by Mr. R. E. Curtiss, of the Observatory at Berkeley; the expenses of the expedition will be defrayed by the well-known liberal benefactor to science, Mr. W. H. Crocker, of San Francisco. The *Observatory* has further learned, through Father Cortie, that certain members of the Calcutta Jesuit Mission will also go to Padang to observe the eclipse.

The most direct route to Padang from Europe is by the Rotterdam-Lloyd line of steamers; a steamer leaving Southampton on April 9 and Marseilles on April 18 is due at Padang on May 12, and there is a return steamer on May 24, due at Marseilles on June 18. Return tickets at greatly reduced rates may be obtained through the British Astronomical Association.

As to the work to be undertaken, the great duration of totality emphatically demands that almost every effort should be directed towards the corona. Indeed, the study of the chromosphere and prominences during eclipses may well be considered to have reached a halting-place, so that in any case the study of these appendages would be considered of secondary importance. The great success which has attended the observation of recent eclipses has in some degree placed observation ahead of solar theory, and it is perhaps for this reason that most of the observations which, we understand, are to be undertaken are along familiar lines. To a certain extent this is, of course, inevitable, for it is always rightly regarded as a prime duty to record the phenomena as completely as possible.

Adequate provision is made for securing pictorial records of the corona. Some of these will be on a large scale to show the finer details of the lower reaches, and others on a smaller scale to depict the extensions seen with the naked eye. Messrs. Maunder and Claxton will utilise the photoheliograph of the Mauritius Observatory, giving pictures of the sun nearly 8 inches in diameter, and in addition will be provided with a 4-inch coronagraph fitted with a negative enlarging lens to give images 2 inches in diameter; the long extensions will be specially attacked with a 4-inch Dallmeyer R.R. lens of 32 inches focus.

At Padang, Mr. Dyson will erect the Thompson photoheliograph of 9 inches aperture, which was successfully employed by the Astronomer Royal in India and Portugal, the photographs being enlarged by a magnifier to a scale of 4 inches to the sun's diameter. The same observer will also take charge of a double camera with 4-inch lenses of relatively short focus to grasp the feeble rays of the longer streamers.

It is probable that Prof. Barnard's instrument will be the coronagraph of 61 feet focus, with which he obtained such admirable photographs of the prominences and inner corona last May. Prof. Todd will again employ his wholesale method of obtaining photographs with cameras in which the exposures are given and plates changed automatically. Coronagraphs of 33 feet 3 inches and 5-feet focus will form part of the equipment of the Jesuit Mission.

For the spectroscopic records, Mr. Maunder is provided with the 2-inch prismatic camera with which Mr. Evershed secured valuable photographs during the eclipse of 1898. With this type of instrument, the principles of which are now sufficiently familiar to render a description superfluous, the spectra of both corona and chromosphere are recorded in the most complete manner. A modified prismatic camera, in the form of an objective grating, will be employed by Mr. Newall in an attempt to photograph the coronal rings. Mr. Dyson will again employ the two slit spectroscopes belonging to Captain Hills, which were used in India and Portugal, one of them being specially adapted for the ultra-violet spectrum. Another important spectroscope will be the prismatic camera forming part of Dr. Nÿland's equipment; this consists of a 6-inch objective and two prisms of 45°, thus duplicating one of the instruments employed in the last two eclipses by Sir Norman Lockyer. The Jesuit Mission will investigate the spectroscopic phenomena with a Rowland concave grating of 36 inches focus, and a prismatic camera of 33 inches focus.

In the case of the slit spectroscopes and the objective grating, the long duration of totality will obviously be an immense advantage, and it is very desirable also that the experiment of giving very long exposures with the prismatic cameras should be made.

Among the more special inquiries, Mr. Newall will again attempt to investigate the rotation of the corona, and also to obtain photographs of the corona in polarised light. The first of these observations is a particularly delicate one, depending for its success on photographically recording the coronal spectrum with sufficient dispersion to exhibit the minute displacements of the bright lines produced by the rotation. The long duration of totality is especially favourable for this observation, but, on the other hand, there is evidence that at the time of sun-spot minimum the coronal lines are of but feeble intensity. Success is therefore by no means assured, but the slit spectroscope to be employed in the experiment is one of great efficiency and convenience, and the attempt is well worth making.

The study of the polarisation of the coronal light is also of some importance. The luminosity of the corona, apart from that due to the luminous gases of the inner corona, has been ascribed to the reflection of solar light by the small particles of which it is supposed to consist, and to the direct emission of light by such particles rendered incandescent by solar radiation. The bolometric observations of Prof. Langley's party at the last eclipse, however, led to the conclusion that the corona appears "neither to reflect much light from the sun, nor, chiefly by virtue of a high temperature, to give light of its own, but seems rather to be giving light in a manner not associated with high temperature" (NATURE, vol. lxiii. p. 67). On the other hand, Mr. Newall, during the same eclipse, found a marked polarisation of the coronal light, indicating that a considerable proportion of the light is reflected. The accumulation of additional data bearing on the origin of the light of the corona, therefore, seems very desirable.

The fact that a British man-of-war will be sent to Padang to render assistance to Messrs. Dyson and Newall is a sufficient guarantee that an adequate record of the general phenomena of the eclipse will be made.

A. FOWLER.

RED RAIN.

AN unusual, though it can scarcely be called a rare, meteorological phenomenon is reported from Italy, and has been made the subject of much highly coloured descriptive writing in the daily Press. The plain facts are thus given by Reuter's correspondent in Palermo in a telegram dated March 10:

"Since last night a dense lurid cloud has hung over this town. The sky appears of a sinister blood red hue, and a strong south wind is blowing. The drops of rain

that fall are like blood. The phenomenon, which is known by the name of blood rain, is attributed to dust from the Sahara Desert, carried here by the wind." And the Rome correspondent of the Agency on the same date says: "The phenomena reported from Sicily have also been observed in Southern Italy. The sky here has a yellow tint, and a violent sirocco is sweeping over the city. At Naples showers of sand have fallen, and the phenomenon of the Fata Morgana has been observed, the sky being of a deep red colour."

Later reports from Algiers describe the same occurrence in North Africa, and the explanation suggested is no doubt correct. It is simply a case of fine sand raised to a great height by one of the "dust devils" or whirlwinds of the Sahara, and carried by the movement of the upper air to a considerable distance before the particles, resisted in their fall by the friction of the air, have succeeded in reaching the ground. If rain happens to fall through such a cloud of suspended dust it naturally carries down a good deal of the material with it, and leaves red stains on drying up. If there is no rain, the fall of dry dust takes place all the same, and this effect is well known at sea in the trade-wind belt west of the Sahara.

It must be remembered that another kind of "blood rain," even more effective in appealing to the fears of the ignorant and superstitious, owes its alarming tint to the presence of minute organisms similar to those of red snow.

Dust rains of one kind or another are fairly frequent. Those of "sulphur" have been traced to the pollen blown abroad from conifers in the spring, and those of "ink," unhappily commoner in this country, to the catching up of smoke from manufacturing districts. Such a black rain, accompanied by intense darkness, fell over nearly 500 square miles in the north of Ireland in February 1898 during a spell of north-easterly wind, while in May 1899 a similar phenomenon was reported over an equal area of central and south-western England.

The precise atmospheric conditions necessary for the raising of dust or smoke into the upper parts of the atmosphere, and for the concentration and descent over special areas, is not yet fully understood; but the careful meteorological observations now made in many parts of Italy may be expected to throw some light on the general phenomenon when dealing with the recent occurrence.

DR. G. M. DAWSON, C.M.G., F.R.S.

GEOLOGICAL science, and Canada in particular, have suffered an irreparable loss in the death of George Mercer Dawson, C.M.G., LL.D., F.R.S., the director of the Geological Survey of that Dominion. He was born at Pictou, Nova Scotia, on August 1, 1849, and was the eldest surviving son of the late Sir John William Dawson, whose death was recorded in NATURE for November 23, 1899.

After studying at the McGill University in Montreal, he came to London and entered the Royal School of Mines in 1869. Here he gained the Duke of Cornwall's scholarship and the Edward Forbes and Murchison medals, thus passing with distinction as an Associate of the School. The training which he received in biology, as well as in geology and mining, was of essential service in his after career.

Having returned to Canada, he was in 1873 appointed geologist and botanist to the North American Boundary Commission, and two years later he joined the staff of the Geological Survey of Canada, becoming assistant director in 1883 and director in 1895.

For nearly thirty years he was thus actively engaged in field-work, gaining a broad and firm grasp of the leading features in the geology of Canada. If, as he himself remarked, much of his work was "of an exploratory character, and only occasionally, and then to a limited extent, precise or finished," it has been none the less important in advancing the science of geology and in furthering the development of the mineral resources of the Dominion. Far better equipped as a pioneer than was possible in the early days of geology, and keen in the examination of fresh ground, his enthusiasm was tempered only by the reluctance in leaving unsolved those problems which required further detailed study. In spite of constitutional infirmity, he possessed a marvellous amount of energy, while as a companion and leader he gained the confidence and affection of all who had the privilege of working with him.

His contributions to science, though mainly geological, were imbued with a general knowledge of natural history, and included observations on such subjects as seals, locusts and freshwater sponges. In geology he dealt at times with all the great formations, with volcanic rocks, with changes in the level of land, and with fluctuations of the great American lakes. In one of his earlier papers, communicated to the Geological Society of London, he described the glacial phenomena of the central regions of North America, and attributed the deposits of the great plain to the action of floating ice. In later papers he gave accounts of the remarkable evidences of glaciation in British Columbia, and of the shore-lines and terraces which extend from the present sea-level up to a height of more than 5000 feet. He then maintained the marine origin of the drifts of the western plains, but stated his opinion without dogmatism, or, as he puts it (in the British Association Handbook of Canada), "under all reserve and subject to further inquiry."

Many of his geological observations were embodied in his official reports, commencing with a general description of the Tertiary Lignite formation which overlaps the Cretaceous strata of the Red River—a report prepared for the British North American Boundary Commission. On the Geological Survey his work lay principally in British Columbia and the North-West Territory. The economic resources necessarily occupied much attention, and the mines and minerals, as well as the more purely scientific problems, were investigated as fully as possible in Vancouver Island, Queen Charlotte's Island, the Yukon territory, and in all parts of British Columbia. He contributed also to journals and transactions of societies in the United States as well as in Canada.

In later years his time was so largely occupied with administrative work, and in the preparation of his annual reports of the progress of the Geological Survey in Canada, that he had little time for recreation. The full value of his work has hardly as yet been appreciated, but there is no doubt that his name will stand in the forefront among Canadian geologists. It is already written permanently in Dawson city, of gold-bearing fame, in recognition of his able researches in that region.

In 1891 he was elected a Fellow of the Royal Society of London, and in the same year he was appointed one of H.M. Behring Sea Commissioners. During the inquiry connected with this Commission he made personal observations on the natural history of seals, and his services were officially recognised by his being made C.M.G. In 1891 also he was awarded the Bigsby Medal by the Council of the Geological Society of London, in appreciation of the value of his researches into the geological structure of Canada. In 1893 he was elected president of the Royal Society of Canada, and in 1896 he was chosen president of Section C at the Toronto meeting of the British Association.

He died on March 2 after a brief illness.

NOTES.

Two letters which have passed between Sir William Anson and Lord George Hamilton, with reference to the recent dismissals at Coopers Hill College, appeared in Wednesday's *Times*. Sir William Anson stated briefly the chief points upon which the request for an inquiry into the case is based. Accepting the decision that some change in the course of studies is necessary, it is urged that (1) the men affected by the proposed changes should have had an opportunity of a hearing when the president recast the course of studies, if only to see whether they would be willing to adapt themselves to the new conditions; (2) when the Board of Visitors considered, and in the main adopted, Colonel Ottley's recommendations, it does not seem to have been suggested to them that the teaching staff had not been consulted, or that they might have been consulted with advantage, or, at any rate, that the gentlemen whose dismissals were in contemplation had a right to be heard; (3) many persons eminent in science have expressed a strong opinion that the proposed dismissals will act injuriously on the scientific education of the country. In reply to Sir William Anson, Lord George Hamilton states that he has already taken steps to meet some of the complaints, and to put the teaching staff of the College upon a better footing. Upon his request the Board of Visitors have stated their readiness to meet to hear at once what the members of the teaching staff affected by the changes may wish to urge against them. In conclusion, Lord George Hamilton acknowledges that the channels of communication between those actually teaching and those in authority over the teachers—viz., the president and visitors—should be widened and quickened, and that a divergence of opinion such as has been revealed is detrimental, if not fatal, to harmonious co-operation. He adds, "I therefore propose to ask the Universities of Oxford, Cambridge and London to each nominate a visitor to be an addition to the present board. I shall ask the board, when so reconstituted, to appoint a committee, including the above, to inquire and report upon the working, discipline and constitution of the College, and the relations of the visitors, president and teaching staff."

THE Croonian Lecture of the Royal Society will be delivered on March 21 by Prof. C. Lloyd Morgan, F.R.S., on "Studies in Visual Sensation."

PROF. J. J. THOMSON, F.R.S., has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of nine persons of "distinguished eminence in science, literature, the arts, or for public services."

PROF. VON WETTSTEIN has been elected president of the Zoological-Botanical Society of Vienna.

THE Imperial Academy of Sciences of Vienna has inaugurated a botanical exploration of southern Brazil during the present year, under the leadership of Prof. von Wettstein and Prof. V. Schiffner.

WE learn from *Science* that the expedition sent by the U.S. Naval Observatory to observe the forthcoming solar eclipse was expected to leave San Francisco for Manila on February 16. From Manila it will be transported to Sumatra by a U.S. warship, and headquarters will be established at Padang about a month before the occurrence of the eclipse. The party includes Prof. Skinner, of the U.S. Naval Observatory, Prof. Barnard, of the Yerkes Observatory, Dr. Mitchell, of Columbia University, Dr. Humphreys, of the University of Virginia, and Mr. Jewell, of the Johns Hopkins University.

THE death is announced of Mr. John Hopwood Blake, F.G.S. Trained as an engineer under Brereton, he became an associate member of the Institution of Civil Engineers. In 1868 he joined the staff of the Geological Survey, and did much field-work in Somerset, in Norfolk and Suffolk, and latterly in Berkshire, Buckinghamshire and Oxfordshire. He was the author of memoirs on the geology of Yarmouth and Lowestoft, and of East Dereham, and had in preparation memoirs on the geology of Reading and on the water supply of Berkshire. Though slow as a worker and diffident in expressing his opinions, the work which he accomplished was performed with much enthusiasm and with the most painstaking care and precision. He died at Oxford on March 5, of angina pectoris, at the age of fifty-seven.

AT the Pan-American Medical Congress, which met recently at Havana, the board which has been engaged in the investigation of yellow fever, consisting of Drs. Reed, Carroll and Agràmonte, made a report. According to Press reports it was stated that two of the main conclusions were that the specific cause of the disease is unknown, and that it can be carried only by mosquitoes. The fever can be produced by a subcutaneous injection of blood from a patient who must have had the disease for not more than two days. Mosquitoes must also bite the patient during the first two days of his illness or they cannot transmit the disease. The board kept an infected mosquito for fifty-one days, when it was allowed to bite a person, who contracted the disease. The board differs from Dr. Finlay in that the latter holds that more than one kind of mosquito can convey yellow fever. The board says there is only one kind that can do so. Dr. Finlay also says that a mosquito can transmit the disease the fourth or fifth day after biting a patient, while the board says that twelve days must intervene. The board reported that non-immunes were allowed to sleep in infected clothing and bedding, but none contracted the disease. Dr. Wilde, of the Argentine Republic, proposed the creation of an international yellow fever board to study means of exterminating the disease.

THE Royal Irish Academy has this year taken a step, after prolonged consideration, which will, it is hoped, still further establish its position in Ireland, and in the world of science and letters in general. It has adopted the principle of the bye-laws of the Royal Society of London, respecting the mode of election of members; the council is now empowered to select a number of persons, not exceeding twelve, in each year, from the list of candidates for membership proposed, and to recommend these to the body of members for election. The members may, at the single annual meeting at which elections now take place, substitute the name of any candidate already proposed for that of any candidate selected by the council; but the number of candidates elected must not be greater than that fixed by the council for that particular year. Changes have been also made in the bye-laws so as to provide for the more frequent introduction of new blood into the council. The position of the Royal Irish Academy becomes at the same time defined in relation to the other great medium of scientific publication and intercourse in Dublin, the Royal Dublin Society. While the latter, by its objects and foundation, must be to a large extent a popular institution, performing its important public functions and scientific work by the support of an extensive body of members, the Royal Irish Academy is able, on the other hand, to maintain its membership as a distinction, and to attract to itself, by this circumstance, those who are mainly concerned with the furtherance of research. A large number of its members are naturally also members of the Royal Dublin Society, and thus enjoy the advantages offered by the publication-committees of both societies. With these two bodies in session, and with the *Irish Naturalist* as a medium for current notes, scientific work in Ireland need not wait long before receiving recognition and discussion.

A REPORT of a second lecture on wireless telegraphy, delivered by Prof. Braun at Strassburg, has been received. The first lecture was referred to in our issue of February 21 (p. 403), in which it was stated that we could not gather whether Prof. Braun had succeeded in obtaining a satisfactory separation of messages received at the same time from different sources. From the present lecture it appears that this difficulty has been overcome in Prof. Braun's system, as in Marconi's and Slaby's, by the use of syntony, which has been utilised, not only to separate different messages, but to augment the effect of the waves received in any particular message. No actual result of long distance trials is given in the report before us, but it is natural to suppose that Prof. Braun's system will succeed in this respect as have the other competing systems. It is interesting to note that all experimenters have been led to this method of separating messages; when wireless telegraphy first attracted attention it was suggested that messages might be confined to their particular destination either by the use of reflectors or by careful tuning of transmitter and receiver. Apparently only the second of these has proved practical; no doubt the long wave-length of the vibrations used have proved fatal to the satisfactory use of reflectors.

THE Board of Trade could not well have arrived at a more satisfactory decision in the conference which was held last week with reference to the proposal to reduce the charge for electric lighting by putting a maximum limit of 6*d.*, instead of 8*d.*, per unit in the provisional orders before Parliament this session. The proposal, which emanated from the Board of Trade, was supported by the London County Council but opposed by several influential electrical bodies, including the Institution of Electrical Engineers and the electrical section of the London Chamber of Commerce, on the ground that it would have the effect of discouraging electric lighting in small country places where the population was scattered. It was urged by Colonel Crompton, on behalf of the Institution of Electrical Engineers, that the advantages to be gained by reducing the maximum in every district would be outweighed by the disadvantage of preventing the spread of electricity all over the country. This is, however, no reason why the dwellers in towns should pay highly that their brethren in the country may enjoy the benefit of electric light, and the obvious solution is that the maximum price should be regulated by the circumstances of the case. This is the solution adopted by the Board; they would fix, said Sir Courtenay Boyle, a normal maximum of 7*d.* a unit, but in the populous districts they would endeavour to make this 6*d.*; in special cases an 8*d.* maximum would be allowed if the undertakers were able to show sufficient cause.

SEVERAL correspondents have written to us with reference to falls of snow or ice crystals such as have been mentioned already (pp. 420, 441). Prof. G. H. Bryan states that a fall of snow stars occurred at Edgbaston, Birmingham, on January 6, and a similar fall, in which the stars were somewhat larger, happened at Bangor on February 15. "In the latter case," he adds, "the crystals which fell in the morning were not sufficient in number to form a coating on the ground, but many of them remained unmelted during the afternoon in shady corners. A few days later isolated stars were again falling, and this time the rays were larger and more feathery." Dr. Abbot noticed a fall of snow crystals at Tunbridge Wells in February, and in connection with the subject he asks whether such crystals should be considered as (1) skeleton crystals, (2) twins, or (3) aggregates of very small hexagons. He remarks:—"What seems to me the most interesting question is the regularity of the angles and distances of the secondary branches; and if we are dealing with skeleton forms, are not ice crystals unique in having these?" Another correspondent says that during a fall of snow crystals at Newcastle at the end of January or beginning of February last some of the crystals were about a quarter of an inch in diameter, and the outline was nearly circular.

SIR COURTENAY BOYLE objects, in the March number of *Macmillan's Magazine*, to many words in common use in science. His objections are partly etymological and partly to the vagueness of connotation of the words. Pliocene, miocene and phonolite are incorrectly formed; and the first two, together with palæozoic, mesozoic, kainozoic, jurassic and triassic are condemned because they are purely relative terms. Electron is objected to because there is sometimes a doubt whether it signifies a minute corpuscle having an electric charge or an electric charge without the corpuscle. Kion and autokion are suggested as preferable to the unsatisfactory words motor and the hybrid automotor.

THE U.S. *Monthly Weather Review* for November, 1900 (the last received) contains an interesting note of lightning from a cloudless sky, by Mr. C. E. Ashcraft, jun., of the Weather Bureau, Dominica. The phenomenon seems to be regarded in the States as one of rare occurrence, but in the West Indies it is frequently observed. The appearance of the flashes is that of sheet-lightning, and they do not seem to be confined to any particular quarter of the sky. The author considers that the theory of the exchange of electricities between vertical currents of air is a plausible explanation, as the phenomenon has always been observed in the evening, usually between seven and nine o'clock, at which time the colder currents of air are descending and setting up a vertical circulation, with steep gradients, and it is also at this time that the maximum electrification of the air occurs. Sometimes the sky is not absolutely clear, a few clouds hanging over the mountains to the east of the station, but the lightning will be seen far out to sea, where not the least vestige of cloud is visible. The flashes have been observed more frequently during the hurricane season. The phenomenon does not appear to be peculiar to the region of Dominica alone, but is said to have been observed in other parts of the tropics.

A NOVEL marine torch, in which acetylene gas is the illuminant, and of special design to ensure immediate ignition on being plunged into water, is described in *Fielden's Magazine*. The torch, it is stated, "simply consists of a plain cylinder of metal, sizes varying from 3 to 8 inches in diameter and from 1 to 5 feet in length. The cylinder, which is sealed at each end, contains in a wire basket a quantity of carbide of calcium and it also contains an air chamber to ensure sufficient buoyancy. At the head of the cylinder a number of burners is arranged adjacent to which is a small chamber containing calcium phosphide, which on contact with water generates phosphuretted hydrogen, ignites and also lights up the acetylene as it issues." The torch, which has no mechanism, is automatic throughout, the only precaution necessary before plunging into water being the removal of a protecting strip of metal by pulling a ring. The illuminating power of the torch can be gathered from the fact that a six-inch torch burns from an hour to an hour and a half with a candle-power of 2000 and a flame 12 inches high, and other torches which are rechargeable will burn from half an hour to ten hours according to size.

A FEW interesting instances of the application of physical instruments to the study of disease are given by Mr. Paget in a short review of the chief events in medicine and surgery between 1800 and 1850, in the *Middlesex Hospital Journal*. The chief influences which caused the great advance in the last ten years of that half century are stated by him to have been, first, the constant and general use of the microscope, both in physiology and pathology. Men left off speaking of tumours as "strange distempered masses"; they set to work to learn their minute

structure, and to interpret from it the clinical facts of each case. Next, the study of fevers, especially Sir William Jenner's observations on the essential difference between typhus and typhoid; and the improved treatment of fevers that was taught and practised by Graves of Dublin; he who said that he desired for an epitaph these words, "He fed fevers." Then, the invention of the ophthalmoscope by Helmholtz and the laryngoscope by Garcia, and the rise of special departments in hospital teaching, and of special work in practice. Next, the exact use of electricity in the diagnosis and treatment of nerve diseases, especially the work of Duchenne. The use of the thermometer followed, not invented all at once like the stethoscope, but very slowly established by years of work and millions of observations, especially the work of Wunderlich. Then the abolition of the old rough-and-ready methods of medical treatment, of useless bleeding and purging and low diet, and shameful abuse of mercury; and the knowledge of the selective action of drugs, especially the physiological study of such drugs as strychnine, curari, atropin and digitalis. Last of all, and best of all, the discovery of anæsthetics.

THE report of the Decimal Association records the progress made in the provision of instruction in the metric system of weights and measures, and the adoption of the system. By an article introduced into the code of elementary schools in 1900, instruction in the principles of the metric system, and in the advantages to be gained from uniformity in the method of forming multiples and submultiples of the unit, is made obligatory in the upper standards. Negotiations are in progress for bringing about a conference in Paris of official delegates and others, representing Great Britain, the United States and Russia, in favour of the adoption of the metric weights and measures in those countries. If this conference be held it will doubtless have important results. Active steps continue to be taken in the United States, and a bill for the introduction of the metric weights and measures in the State Departments is now before congress at Washington, and has been reported on favourably by the committee on coinage, weights and measures. The growth of public opinion in this country in favour of the metric weights and measures has attracted much attention in the United States, and has given an impetus to the movement there. In Canada, the Government are said to be seriously considering the adoption of the metric weights and measures, and several encouraging communications have been received by the Decimal Association from residents in that country. In Russia there is a growing disposition on the part of the Government to adopt the metric system, and there are good grounds for believing that an important step will be taken in that country shortly. In July last a report was issued by the Foreign Office which contained the replies of Her late Majesty's representatives in Europe to a circular addressed to them by the Marquis of Salisbury, asking for information as to the actual experience of nations which had adopted the metric system. The replies showed that in all cases the change was made without much difficulty, that there had never been any desire to return to the former system in use, and that the adoption of the metric system had assisted in the development of the trade of the countries which had adopted it. The second part of this report has just been published, and bears out these conclusions.

A SIMPLE elementary exposition of the principles of thermodynamics treated by means of the familiar p, v diagram is given by Mr. Robert H. Thurston in the *Journal* of the Franklin Institute, under the title "Elementary Graphics and Geometry of Thermodynamics."

IN the *Rendiconto* of the Naples Academy (January), Prof. Domenico de Francesco discusses certain problems in the dynamics of pseudospherical space. In a previous memoir the author gave an investigation of "motion under no forces" for such space, and he here interprets for the same kind of space the differential equations which in ordinary space represent motion about a fixed point under arbitrary forces.

IN the ordinary theory of elasticity it is proved that when a body occupying a simply connected region is not acted on by either surface tractions or bodily forces the strain vanishes at every point of the interior. Nevertheless, bodies may exist in which internal tensions act; for example, we may imagine a split ring the ends of which do not meet, and suppose these ends brought into contact and welded together. In the *Atti dei Lincei*, x. 3, Signor G. Weingarten points out that in all such cases surfaces must exist at which the displacements are discontinuous, and he discusses the properties of such surfaces. The subject is an interesting one, but the paper is only a short note.

IN the *Journal* of the Franklin Institute, Mr. John Price Jackson discusses the use of electricity for coal mining. Electricity may be economically used for lighting, hoisting purposes, pumping, cutting, drilling, running fans, operating breakers or washers, propelling bucket or belt-lifts, driving repair shop apparatus, &c. The question as to whether any or all of these applications shall be used is dependent directly upon local conditions. If a system of mines owned by one company are supplied from a central power-house, it is clearly possible to entirely do without local steam plants at the individual mines. Such an arrangement has several advantages in the matter of economy of fuel, the very great economy in repairs and a still further economy in working speed efficiency.

Science Abstracts always contains statements of results of interest to all students of science, as well as descriptions of work of special value to those engaged in work in physics and electrical engineering. To the latter the periodical is invaluable, and it should find a permanent place in the library of every Technical Institute and School of Science, as well as in educational institutions of higher rank. Many subjects are described in the abstracts, which are concise, well arranged, and of real importance to workers in all branches of physical science. There is no better way of creating an interest in scientific work and arousing a spirit of emulation than by making students familiar with the progress of scientific knowledge.

THE *Irish Naturalist* for March contains an excellent account of the natural history of that comparatively rare visitor to the British coasts, the grey phalarope, by Mr. C. J. Patten.

IN the *Entomologist* for March, Mr. W. L. Distant describes two new species from West Africa of that remarkable genus of Heteroptera known as Pephricus, the members of which so curiously resemble crumpled and broken leaves. The genus is of especial interesting as being one of the first in which "mimicry" was noticed, Sparman, who discovered the type species in 1775, mentioning his surprise on observing signs of active life in what he had taken for a dead leaf gnawed by caterpillars.

A HIGHLY suggestive and thoughtful paper on the question of the arboreal ancestry of marsupials and the mutual relations of the mammalian subclasses appears in the February number of the *American Naturalist*, by Mr. B. A. Bensley, who is now in this country studying marsupial ancestry. Taking as a text Dollo's view that marsupials were originally arboreal, that, on account of their foot-structure, they could not have been ancestors of placentals, and that they themselves are degenerate placentals, Mr. Bensley contrasts this with Huxley's scheme of mammalian evolution. According to the latter the Prototheria, which became specialised into the modern monotremes, gave

rise to the Metatheria, whose specialised representatives are the marsupials; while the Eutheria, specialised into modern placentals, are likewise an offshoot from the Metatheria. This phylogeny, thinks the author, is the most probable of all. It is urged that the imperfect placenta of the bandicoots, instead of being, as considered by Mr. Hill, vestigial, may be an instance of parallelism, and that in marsupials generally the allantois failed to form a placental connection. Owing to the antiquity of both placentals and marsupials, the arboreal character of the feet of the modern forms of the latter is of little importance. Further, it is considered that too much importance has been assigned to the characters distinguishing monotremes from other mammals; fœtal marsupials showing a monotreme type of coracoid, while it is probable that in the long run it will be found impossible to maintain the essential dissimilarity between the milk-glands of monotremes and those of other mammals.

ANOTHER paper in the same issue of the *American Naturalist*, by Mr. A. E. Ortman, deals with the subject of the geographical distribution of animals and plants, its title being the "Theories of the Origin of the Antarctic Faunas and Floras." Sir Joseph Hooker first, and the late Dr. L. Rütimeyer second, are credited with being the pioneers of the idea of the essential unity of the southern faunas. Rütimeyer, indeed, distinctly states that "we should take a part of the present faunas of South America, South Africa and Australia for remnants of an old fauna that spread over a large extent of the Antarctic continent, and that this Antarctic continent was the centre of origin of a peculiar Antarctic fauna." Here it may be appropriately mentioned that Dr. Stejneger, in a paper in the same journal, feeling, like many other writers, the urgent want of a word denoting both fauna and flora collectively, proposes the term "Biota" to fill the gap. If this were adopted, he adds, "*biotic* would then signify 'pertaining to or treating of a biota,' as, a biotic publication, a biotic region."

IN continuation of his earlier researches, Dr. Carl Sapper contributes a paper on the ethnography of southern Central America to the February number of *Petermann's Mitteilungen*. The paper gives an account of the languages of the region, with a map showing their distribution in 1899, and a comparative review of the civilisations of the different Indian tribes.

DR. EMIL SCHLAGINTWEIT returns to the question of the name of the highest mountain in the world in an article in the current number of *Petermann's Mitteilungen*. After discussing specially the Tibetan names Chomo Kankar and Tsering chenga, strictly Jomo gangs dkar and Thse ring mched lnga, Dr. Schlagintweit reasserts his former decision in favour of the name *Gaurisankar-Everest*.

THE *Verhandlungen* of the Berlin *Gesellschaft für Erdkunde* contains a paper on the geological history of the North German plain, by Prof. Wahnschaffe. An excellent summary is given of recent additions to our knowledge of the glacial phenomena of this region, especially those derived from deep borings. The *Zeitschrift* of the same society contains two important papers, one on the country and people of north-eastern Tibet, by Dr. K. Futterer, and a discussion of Dr. S. Passarge's observations of atmospheric pressure and temperature in the Lake Ngami region as applied to the determination of heights, by Herr G. von Elsner.

THE report of the Danish Meteorological Institute on the ice of the Arctic seas during 1900 has just been issued. With the support of the Seventh International Geographical Congress the Institute has been enabled to make this report fuller than in former years; not only is full information given from the Atlantic-Arctic waters, but a number of observations from the Bering and Beaufort Seas. The general features during the season were—great masses of ice in the north-west part of Barents Sea and round Spitsbergen, considerable masses of ice in the Kara Sea, less ice than in a normal year between Franz Josef Land and Novaya Zemlya and under the east coast of Greenland, normal conditions off south-west Greenland, and particularly favourable conditions off Labrador and in Baffin's Bay.

In the third part of his "Geology of the Boston Basin," Mr. W. O. Crosby deals with "The Blue Hills Complex" (*Occasional Papers*, Boston Soc. Nat. Hist., 1900). This complex is the area of granitic rocks and associated Cambrian strata in eastern Massachusetts, which includes the Blue Hills and the country eastwards to Quincy and the northern parts of Braintree and Weymouth. In this region is the famous quarry which yielded *Paradoxides Harlani* of the Middle Cambrian, but the Lower Cambrian with *Olenellus* is likewise represented. No recognisable trace of the floor upon which the Cambrian strata were deposited has been discovered, but that Upper Cambrian or Potsdam strata exist, or formerly existed, in the region is evidenced by fossiliferous pebbles in the Carboniferous rocks, which, together with drift deposits, occupy much of the ground. The Cambrian strata were strongly folded and invaded by great bodies of igneous rocks not later than Devonian times. All these rocks and the effects of metamorphism are fully described and illustrated. The author also discusses the relations of the Blue Hills complex to the peneplains of eastern Massachusetts, and to the Glacial phenomena of the area. The palæontology of the Cambrian strata is dealt with by Mr. A. W. Grabau, and the leading fossils are figured.

A NEW part of the revised second edition of Prof. Arnold Lang's "Lehrbuch der vergleichenden Anatomie der wirbellosen Thiere," dealing with the Protozoa, has been received from the publisher, Mr. Gustav Fischer, Jena. The book has been completely revised and partly rewritten.

THE *Monist* for January contains the translation of an address, by Prof. Ludwig Boltzmann, on "The Recent Development of Method in Theoretical Physics." This address was originally delivered at the congress of the Gesellschaft deutscher Naturforscher und Aerzte in Munich in September 1899.

A NEW meteorological journal has been established under the title *Climate*, with Mr. N. A. Demchinsky as editor. The periodical will appear twice a month, and all its contents will be in four languages—Russian, German, French and English. The chief object is to apply to weather prediction Mr. Demchinsky's theory that the moon is the chief factor in meteorological changes.

A LIST of the birds of the Bristol district is given in the volume of *Proceedings* of the Bristol Naturalists' Society (vol. ix. part 2) just published. Other papers are on a Rhætic section at Redland—a suburb of Bristol, by Mr. W. H. Wickes, with additional observations on the beds, by Mr. J. Parsons, and on Triassic deposits at Emborough, by Prof. Lloyd Morgan, F.R.S., and Mr. S. H. Reynolds.

THE second part of the report on a bathymetrical survey of the fresh-water lochs of Scotland, by Sir John Murray, K.C.B., F.R.S., and the late Mr. Fred P. Pullar, appears in the March number of the *Geographical Journal*. An account of the first part of the survey was given in NATURE of May 17, 1900 (vol. lxii. p. 65). The second part treats of the remaining lochs of the drainage basin of the Forth, viz., Loch Chon, with Lochan Dubh, Loch Ard, and Lake of Mentieth in Perthshire, and Loch Leven in Kinross-shire. The same number of the *Journal* contains a report of the special meeting held to commemorate the progress of geographical discovery during the Victorian reign.

THE general appendix to the annual report of the Smithsonian Institution for 1898, which has just been received, consists of

reprints and translations of thirty-six papers of wide scientific interest. Many branches of science are represented by the papers, and the whole collection forms a most interesting and valuable survey of subjects prominently before the scientific world in 1898. Limitations of space prevent us from giving a list of the papers reprinted from various reviews and scientific periodicals, but we are glad to direct attention to the following translations:—Recent progress accomplished by aid of photography in the study of the lunar surface, from a paper by MM. Loewy and Puiseux; the Le Sage theory of gravitation, translated from a paper by M. Prevost, with introductory note by Dr. S. P. Langley; the extreme infra-red radiations, by Dr. C. E. Guillaume; the perception of light and colour, by M. G. Lechalas; progress in colour photography, by M. G. H. Niewenglowski; oceanography, by M. J. Thoulet; the relation of plant physiology to the other sciences, by Dr. Julius Wiesner; *Pithecanthropus erectus*—a form from the ancestral stock of mankind, by Dr. E. Dubois; our present knowledge of the origin of man, by Prof. E. Haeckel; the laws of orientation among animals, by Captain G. Reynaud; the theory of energy and the living world—the physiology of alimentation, by M. A. Dastre; a sketch of Babylonian society, by Herr F. E. Peiser; the excavations of Carthage, by M. P. Berger; the origin of African civilisations, by Dr. L. Frobenius; dogs and savages, by Dr. B. Langkavel; the life and works of Brown-Séquard, by M. Berthelot. It will be seen from this list that the volume contains no less than sixteen translations of papers on important subjects. By publishing these translations, with the reprints, the Smithsonian Institution records the progress of scientific thought in a most serviceable way, and enlarges the outlook of men of science who do not read German and French with facility.

THE discovery of the organo-metallic compounds nearly half a century ago, by Frankland, opened up a wide field of organic synthesis, which has for some time been regarded as exhausted. It has, however, been recently shown by M. Grignard that many syntheses which are effected only with difficulty with the zinc alkyls can be carried out with great ease with magnesium compounds. In the current number of the *Comptes rendus* M. Grignard gives a *résumé* of his work in this direction, together with a theoretical study of the reaction. By the action of magnesium upon an alkyl iodide the compound RMgI is first formed, and this condenses readily with aldehydes and ketones, without there being any necessity to isolate the organo-metallic compound, giving ultimately secondary or tertiary alcohols, the yields being as high as 50 per cent.

THE additions to the Zoological Society's Gardens during the past week include a Pardine Genet (*Genetta pardina*) from West Africa, presented by Lady Moor; a Common Otter (*Lutra vulgaris*), British, presented by Mr. W. Radcliffe Saunders; a Yak (*Poephagus grunniens*) from Tibet, presented by Mr. A. E. Pitt-Rivers; a Blue Whistling Thrush (*Myiophoneus coeruleus*) from the Himalayas, a Jerdon's Green Bulbul (*Chloropsis jerdoni*), a Black-crested Yellow Bulbul (*Otocampsa flaviventris*), two Blyth's Hill Partridges (*Arboricula rufigularis*), an Indian Green Barbet (*Thereiceryx zeylonicus*) from India, a Great Barbet (*Megalaema virens*) from China, presented by Mr. E. W. Harper; a Grey-backed White-eye (*Zosterops dorsalis*) from Australia, presented by Mr. D. Seth-Smith; a Buzzard (*Buteo vulgaris*), European, presented by Mr. J. A. Harvie Brown; a Black Kite (*Milvus migrans*), European, presented by Mr. H. Wreford; a Red Kangaroo (*Macropus rufus*) from Australia, two Striated Jay Thrushes (*Grammatoptila striata*) from the Himalayas, two Rufous-chinned Laughing Thrushes (*Ianthocincla rufigularis*), a Rat Snake (*Zamenis mucosus*) from India, deposited; a Black-faced Kangaroo (*Macropus melanops*) from Tasmania, a Barraband's Parrakeet (*Polytelis barrabandi*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

NOVA PERSEI.—The position of the star, as given by the meridian circle at Greenwich, is

$$\left.\begin{array}{l} \text{R.A.} = 3^{\text{h}}\ 24^{\text{m}}\ 28^{\text{s}}\cdot 21 \\ \text{Decl.} = +43^\circ\ 33'\ 54''\cdot 8 \end{array}\right\} (1901).$$

During the fortnight since its discovery the star has undergone a remarkable series of changes both in brightness and spectrum.

Variation in Brightness.

	Mag.		Mag.		Mag.
Feb. 22	2·7	Feb 28	2·1	March 6	2·9
23	0·10	March 1	2·2	7	3·0
24	0·65	2	2·3	8	3·2
25	1·0	3	2·4	9	3·5
26	1·1	4	2·6	10	3·7
27	1·5–2·1	5	2·7	11	3·9

In the current issue of *Comptes rendus* (vol. cxxxii. pp. 535–538) M. H. Deslandres describes his observations on the spectrum made with the spectroscope designed for line of sight measures at the Meudon Observatory. The photograph of the star's spectrum was obtained alongside a comparison showing the lines of iron, calcium, hydrogen, helium and air.

After noting the great breadth of the bright lines, he states that the middle of each band is displaced *towards the red* with respect to the terrestrial spectrum. The spectrum is similar to Nova Aurigæ, but the lines are broader. He then draws attention to the minute structure of the $H\beta$ (F) line of hydrogen, which shows *three* maxima of brightness, the more refrangible component being the most intense. The other lines show similar structure, but not so clearly.

On the other hand, the calcium lines at H and K each show a fine, clear, dark line, the only sharp lines in the spectrum; both are displaced slightly towards the red M. Deslandres discusses the two explanations of the width of the lines, that of Doppler-Fizeau ascribing the appearance to motion, the other, suggested by the experiments of Humphrey and Mohler and Wilsing, indicating the cause to be the great pressure to which the gases are probably subjected. He concludes by ascribing the group of lines immediately less refrangible then $H\beta$ to magnesium and asterium, but these have been traced by other observers to the most prominent enhanced lines of iron.

CO-OPERATION IN OBSERVING VARIABLE STARS.—*Circular* 53 of the Harvard College Observatory consists of an outline plan drawn up by the Director, Prof. E. C. Pickering, for enabling a systematic investigation of variable stars to be made by the cooperation of observers in various localities. This has been induced by the fact that the number of long-period variables is now so great that many of them are neglected.

In the case of variables of small range the difficulty is not so great, as the variation is in most cases regular, but many of the variables of long period appear to change irregularly, and continuous observations are required until the nature of the changes are known. Moreover, the range is, in many cases, so great that the errors of observation are not sufficient to affect seriously the form of the curve.

It is recommended that in the vicinity of each variable a series of about twelve comparison stars be selected, the brightest being slightly brighter than the variable at maximum, and the faintest fainter than the variable at minimum. The intermediate ones should gradually decrease in brightness with about half-a-magnitude differences.

The actual magnitudes of all such stars brighter than the *seventh* magnitude can be supplied from the meridian photometer records, and means are now being adopted for furnishing on a uniform scale the brightness of the faintest stars likely to be visible in any telescope. At least one observation of each star should be made every month.

For searching out comparison stars the excellent charts of Father Hagen are recommended for stars fainter than the ninth magnitude. For brighter ones copies have been made of the Bonn Durchmusterung charts, giving 3° square about each variable, and these will be supplied to experienced observers willing to co-operate in the work. A list of seventy-three variables for which these charts will soon be ready is furnished.

DIMENSIONS OF THE SATURNIAN SYSTEM.—Prof. T. J. J. See has recently completed a long series of measures of the

various planetary systems with the 26-inch refractor of the United States Naval Observatory at Washington. In the *Astronomische Nachrichten* (Bd. 154, Nos. 3686–7) he gives the details and results of the investigations of Saturn, including measures of the planet, rings, and the satellite Titan. He attributes much of the consistency of the values determined to the use of various colour screens placed between the eye and the telescope, which reduces or eliminates entirely the secondary spectrum produced by the objective, thereby enabling a much more sharply defined disc to be obtained.

In addition to his own recent measures, the author also brings together previous work on the subject from 1659. The following is a summary of the new determinations:—

	″	km.
External diameter of the outer ring ...	=40·304	278,768
Internal diameter of the outer ring, *or* External diameter of Cassini's division	=34·787	240,610
Diameter of the centre of Encke's division	=37·777	261,290
Width of Encke's division	= 0·107	740
Total width of the outer ring	= 2·758	19,076
Width of the outer part of the outer ring	= 1·237	8,556
Width of the inner part of the outer ring	= 1·414	9,780
Width of Cassini's division	= 0·418	2,891
External diameter of central ring ...	=33·951	234,827
Internal diameter of central ring, *or* External diameter of dusky ring ...	=25·952	179,501
Width of central ring	= 4·000	27,667
Internal diameter of dusky ring ...	=20·582	142,359
Black space between Saturn's globe and dusky ring	= 1·567	10,838
Equatorial diameter of Saturn	=17·448	120,682
Assumed oblateness of Saturn (H. Struve)	= 0·1013	
Polar diameter with this oblateness ...	=15·681	108,457
Assumed mass of Saturn (Bessel) ...	= 1:3501·6	
Resulting mean density of planet ...	= 0·1234=0·679 that of water.	
Diameter of the satellite Titan ...	= 0·487	3,368

HYDROGEN IN AIR.

IN a recent number of the *Annales de Chimie et de Physique* (January, 1901), M. Armand Gautier, professor of chemistry at the École de Médicine, Paris, gives a connected account of his researches on the combustible gases of the atmosphere. These researches have occupied some years, they have been carried out with extraordinary care and completeness, and they have yielded results of very great interest both in regard to their main object and also in relation to incidental scientific questions.

The most striking fact elicited by M. Gautier is that pure air contains free hydrogen as a normal constituent to the extent of about two volumes in 10,000. This conclusion, taken in conjunction with the recent experiments of Profs. Liveing and Dewar (NATURE, December 20, 1900, p. 189), in which they record the isolation of a fraction of air containing 43 per cent. of hydrogen, which they actually exploded, seems to admit of no doubt.

Analytical Methods.—M. Gautier set himself to determine the character and amount of combustible gases in the atmosphere by aspirating a large volume of air through a train of absorbents. Nothing could be more obvious and simple in principle than such a method; the difficulty of making it available for determining with any degree of certainty the character and quantity of very small amounts of combustible gases will, however, be thoroughly appreciated by chemists.

The first part of M. Gautier's memoir is devoted to a description of the preliminary work which was necessary for the selection and proper use of the absorbents. Beginning with carbon dioxide, he confirmed the previous observation of Boussingault and Eliot and Storer that carbon dioxide is very difficult to absorb from a large admixture of other gases. After circulating 90 litres of ordinary air during forty-eight hours through a tube 80 centimetres long and containing glass beads moistened with caustic potash solution of density 1·3, it was found that 10·7 c.c. per million of CO_2 remained unabsorbed. A satisfactory absorbent in respect both to rapidity and completeness was found in barium hydrate, either dissolved or simply moistened with water. This substance would, of course, also absorb other acid gases, such as H_2S, SO_2 and NO_2.

The desiccation of air by sulphuric acid was also shown to be incomplete; a satisfactory agent was found in phosphoric oxide previously heated with oxygen at 260° C. to get rid of lower oxides.

For the absorption of minute quantities of carbon monoxide the ordinary reagents are ineffective and a new one was found in iodine pentoxide. Air containing 1/100,000th of the gas loses it completely and at once when passed over the pentoxide heated to 70° C. Carbon dioxide, oxygen, nitrogen, hydrogen, marsh gas have no action on the oxide at that temperature, and other more strongly reducing gases, such as alcohol vapour and benzene when much diluted are also without action. When carbon monoxide acts upon iodine pentoxide, iodine and carbon dioxide are produced; the iodine is absorbed by a tube containing finely divided copper and the carbon dioxide by barium hydrate. The estimation of hydrogen and hydrocarbons is next dealt with. When a mixture of 50 c.c. of hydrogen with 235 litres of pure air was passed over heated oxide of copper the hydrogen was entirely burnt provided that a tube of 70 centimetres was employed. With a tube of 30 centimetres, only 70 per cent. of the hydrogen was burnt. When using shorter tubes in subsequent experiments the weight of water obtained had to be multiplied by a factor in order to give the effect of an "infinite" tube of copper oxide.

When diluted marsh gas is passed over heated copper oxide there is neither complete combustion nor equivalent combustion of the carbon and hydrogen, and here also the use of factors is necessary. The hydrogen burns in greater proportion than the carbon. With a diluted mixture of marsh gas and hydrogen it was found that the presence of the hydrogen facilitated the combustion of the hydrogen of the marsh gas but retarded that of the carbon. Admixture of the copper oxide with spongy platinum or with other metallic oxides did not improve the efficiency. It was found that the copper oxide, after continued heating to redness, gradually lost its power of oxidising, and after 1500 hours it was without effect upon hydrocarbons, and it only partially oxidised free hydrogen.

For a detailed description and drawing of the apparatus the original memoir must be consulted. The air was filtered from suspended impurities by filtration through glass wool, its carbon dioxide was then absorbed—and in this connection the author devised a special form of absorption tube which he strongly recommends—water was then absorbed and the air entered the combustion tube. The combustion tube was heated in a furnace of special construction, in which great uniformity of temperature could be maintained from end to end. Water and carbon dioxide formed by combustion were then absorbed, and the apparatus terminated in an aspirator, a "decanteur" and a meter. There were in all twenty-eight pieces in the train; they were connected together by clamped india-rubber joints made from purified tubing, which experiment showed to be proof against diffusion.

The Air of Paris.—Beginning first with towns, M. Gautier examined the air in the region of the École de Médicine. The average ratio of carbon and hydrogen found corresponded pretty nearly to CH_4, but there was evidence at times of some more highly carburetted hydrocarbon being present, at others of free hydrogen.

There was no evidence of hydrocarbons of the ethylene or acetylene series being present.

The quantity of carbon monoxide found was extremely small, it averaged 2·11 volumes per million, but this included one very abnormally high instance. Neglecting this one instance the average of ·56 volume per million was obtained. The quantity of carbon monoxide varied in different places; it increased in densely populated places. In a small room at the laboratory heated by an old-fashioned faïence stove and illuminated for several hours by three gas jets 12·3 volumes were found. On the whole the quantity of CO and unsaturated hydrocarbons in town air may be said to be insignificant.

The Air of Forests.—The next experiments related to the air of forests, and the station fixed upon was a clearance in the middle of a wood at Lainville, 70 kilometres from Paris.

Here the proportion of carbon to hydrogen pointed distinctly to the presence of free hydrogen along with marsh gas. It did not seem probable that the hydrogen came directly from living vegetation, but it was possible that it might arise from decomposition going on in the soil, and it was therefore decided to make analyses in localities where this possible source would be removed to a large extent.

Mountain Air.—With the object just referred to, the next station selected was in the Pyrenees on the Pic Canigou, a barren mountain 2785 metres in height. The transport of the apparatus to this remote station required six porters and mules, and M. Gautier with his *préparateur* and one guide were left to make the best of a rock cabin amidst the snow, fires being suppressed in order to avoid contamination of the atmosphere.

Under these cheerless conditions a series of determinations was made which amply realised the anticipation that in the absence of vegetation and soil the proportion of marsh gas would diminish. The quantity found was 2·19 volumes per 100,000 as against 11·3 for the air of woods and 22·6 for the air of Paris.

The quantity of free hydrogen reached 17 parts per 100,000.

Sea Air.—M. Gautier now decided to get rid of vegetation altogether by going out to sea, and took up his station during the autumn equinox at the iron lighthouse of the Roches-Douvres, 40 kilometres from the coast of Brittany. He arrived after a series of north-west gales, and was, he says, altogether *très favorisé par les circonstances.* Analysis showed a fall in the proportion of carbon to 1/33 of what it was in mountain air, that is, to an almost negligible quantity. There was an increase in the amount of free hydrogen to 19·5 vols. per 100,000. It appears, therefore, that the air over the sea and at very high altitudes is nearly free from hydrocarbons, and that it contains two vols. in 10,000 of free hydrogen, a proportion, it will be observed, about two-thirds of that of the atmospheric carbonic acid.

Source of the Gases.—In the concluding section of his memoir, M. Gautier discusses in more detail the nature of the accessory combustible gases in the air and the origin of atmospheric hydrogen. He concludes that, subject to variations, the combustible gases of Paris air may be set down as follows, in volumes per 100,000:—Free hydrogen 19·4, methane 12·1, benzene vapour or analogous compounds 1·7, carbon monoxide and traces of olefines and acetylenes ·2.

It remains now only to show that the presence of hydrocarbons in air is in accordance with established geological facts, and that it is connected with the occurrence of the larger quantities of free hydrogen. M. Gautier points out that methane is exhaled from many soils, that it is the chief constituent of fire-damp, that it occurs with petroleum and is emitted by volcanoes, especially by mud volcanoes. Hydrogen often accompanies methane in these cases, and has been found in the fumerolles of Iceland and Tuscany. These outbursts are only extreme manifestations of actions which have been silently in continual progress for ages. The occurrence of hydrogen occluded in rocks has been pointed out by Fouqué and by Tilden. M. Gautier has himself greatly extended earlier researches. He finds that many specimens of granite treated with water at 280° C. or with dilute acids at 100°, yield a considerable volume of gas. Thus, in one case, a kilogramme of granite heated with diluted phosphoric acid gave the following volumes in c.c.:—H_2S 1·2, CO_2 272·6, C_2H_2 12·3, CH_4 trace, N_2 (rich in argon) 230·5, H_2 53.

It seems probable that when the igneous rocks were solidifying and their components crystallising, they included small quantities of the primitive earth materials which now form the subjacent zone, that is to say, sulphides, nitrides, argonides, heliides, hydrocarbons, carbides, fluorides, iodides, phosphides, arsenides, &c. These substances, by the action of water, aided or not by acids, gave rise to the observed gases. As to the hydrogen, M. Gautier is assured by experiments, which he does not now detail, that it comes from (*a*) the action of water at a red heat on ferrous compounds, (*b*) the destruction by heat of hydrocarbons formed previously by the action of water on metallic carbides, (*c*) in a less degree by the action of water at a red heat on certain nitrides.

Hydrocarbons come from the action of water on small quantities of metallic carbides, especially those of aluminium and iron, included in the rocks.

Many more details of geological and chemical interest are given by M. Gautier. He insists that it is not necessary to imagine that water penetrates to the molten material lying below the solid crust of the earth. It is sufficient for the water to reach the low layers of rock containing these small quantities of included raw materials. On the other hand, it is not to be supposed that the gaseous products of the action of water on the raw materials will all escape from the surface. Some of the gases will combine with the rocks, and some on reaching the region of oxygen will be oxidised; but others, including methane, the petroleum hydrocarbons, nitrogen and hydrogen, not readily oxidised except at high temperatures, will escape into the air.

M. Gautier deals briefly with the question as to whether the hydrogen will tend to accumulate in the upper regions of the atmosphere. Without committing himself to a definite opinion, he quotes the views of Dr. Johnstone Stoney as to the impossibility of the earth's gravitational attraction being sufficient to retain helium or hydrogen. If the view is accepted that some of the hydrogen molecules at the fringe of the atmosphere have a velocity outwards of 11,000 metres per second, their escape would be possible, and we should have to picture a continual flux of hydrogen from the earth's surface through the atmosphere into interstellar space.

It is interesting to note that Profs. Liveing and Dewar incline perhaps to a different view. They say "if the earth cannot retain hydrogen or originate it, then there must be a continued accession of hydrogen to the atmosphere (from interplanetary space), and we can hardly resist the conclusion that a similar transfer of other gases must also take place."

Whatever view be correct as to the source and retention of atmospheric hydrogen, there can be no longer any doubt not only of its presence but of its abundance, and the establishment of this fact marks an advance in knowledge highly important from many points of view.

A. S.

SCIENTIFIC AGRICULTURE IN THE UNITED STATES.[1]

AGRICULTURAL experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories of the United States. Agricultural experiments have been begun in Alaska with the aid of national funds, and an experiment station is in operation in Hawaii under private auspices. In each of the States of Alabama, Connecticut, New Jersey and New York a separate station is maintained wholly or in part by State funds, and in Louisiana a station for sugar experiments is maintained partly by funds contributed by sugar planters. Excluding the branch stations established in the several States, the total number of stations in the United States is 54. Of these 52 received the appropriation provided for in the act of Congress above mentioned. The total income of the stations is about 1,143,334 dollars, of which 720,000 dollars was received from the National Government, the remainder, 423,334.93 dollars, coming from the following sources: State Governments, 240,300.20 dollars; individuals and communities, 12,100 dollars; fees for analyses of fertilisers, 75,294.42 dollars; sales of farm products, 69,312.60 dollars; miscellaneous, 26,327.71 dollars. In addition to this the Office of Experiment Stations has an appropriation of 40,000 dollars for the past fiscal year, including 10,000 dollars for the Alaskan investigation.

The stations employ 678 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows:—Directors, 71; chemists, 148; agriculturists, 68; experts in animal husbandry, 9; horticulturists, 77; farm foremen, 21; dairymen, 23; botanists, 52; entomologists, 48; veterinarians, 26; meteorologists, 17; biologists, 7; physicists, 7; geologists, 5; mycologists and bacteriologists, 20; irrigation engineers, 5; in charge of substations, 16; secretaries and treasurers, 24; librarians, 9; and clerks, 43. There are also 48 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds and buildings, apiarists, herdsmen, &c. Three hundred and eight station officers do more or less teaching in the colleges with which the stations are connected.

During 1899 the stations published 445 annual reports and bulletins, containing 16,924 pages. Besides regular reports and bulletins, a number of the stations issued Press bulletins, which were widely reproduced in the agricultural and county papers.

In a recent report on the work and expenditures of the stations, Mr. A. C. True, the Director of the Experiment Station Office, makes the following general statements:—

The work of the stations during the past year has for the most part been along the same lines as heretofore, and in the

[1] Abridged from the *Experiment Station Record* (vol. xi. No. 9), published by the U. S. Department of Agriculture.

aggregate a large amount of useful work has been accomplished. By their own efforts and with the aid of the colleges of agriculture and the State boards or commissioners of agriculture, the stations are bringing their work home more closely to the farmers through publications, farmers' institutes, agricultural associations, home reading courses, and the Press. It is becoming evident that farm practice in the United States is being materially affected by the work of the stations, and they are more and more relied upon by our progressive farmers for advice and assistance.

The wisdom of Congress in making the Hatch fund a research fund is every year becoming more apparent. This Department is therefore disposed to more strongly insist on a strict interpretation of this act in this direction, and to hold that it is not only in accordance with the obligation, but also to the interest of the States, to devote the Hatch fund to investigations in agriculture and to supplement this fund as far as may be necessary to promote the interests of agriculture in other lines.

The movement for the improvement of courses of agriculture in the colleges with which the stations are connected is steadily growing. The past year has witnessed many changes for the better as regards specialisation of the work of instruction and the development of courses suited to the varied needs of students. More than ever before, the colleges are reaching out beyond their class rooms and are carrying useful instruction to the farmers through farmers' institutes, correspondence courses, and other forms of so-called university extension. As this outside work becomes better organised it is more apparent that it belongs to the college rather than the station.

As the work of both college and station grows in extent and complexity, it becomes more apparent that in order to perform the most efficient service the station should be organised strictly as a separate department of the institution with which it is connected, and that it should have an organisation so compact that its work may proceed in accordance with a schedule carefully planned and energetically administered. To secure this end, experience shows that it is quite desirable that the station should have a competent executive officer, who can devote his time very largely to planning and directing its operations, managing its general business, and representing its interests before the public. It is encouraging to observe that in several States during the past year these considerations have led to the more complete separation of the business of the station from the general business of the college, and to the appointment of a director of the station as a separate officer.

From the very first the stations in the United States have been largely engaged in the inspection of commercial fertilisers, and this work has been so efficiently and usefully conducted that from time to time additional inspection duties have been laid upon the stations. The movement for the establishment of different kinds of inspection service under authority of the National and State Governments is growing apace, and it is very important that the relations of this work to the other functions of the stations should be clearly understood. Soon after the establishment of the stations under the Hatch Act this Department ruled that the funds appropriated under this Act could not be legitimately applied to pay the expenses of the inspection and control of fertilisers. The same principle holds good with reference to other forms of inspection service demanded of the stations. While the methods and usefulness of inspection in any particular line are still problematical, it may be justifiable for a station to take up this work to a limited extent, but as soon as it becomes a matter of routine business the State should provide funds for its maintenance. If it seems expedient that any part of the inspection service should be performed by the station under State laws and at State expense, the matter should be so arranged as not in any way to interfere with the investigations of the station. It is a great mistake to divert the time and energy of a competent investigator to the toilsome routine work of inspection service.

The number and importance of the experiments which the stations are conducting in cooperation with practical farmers and horticulturists have greatly increased of late. Thousands of such experiments are now annually conducted in the United States. These range all the way from simple tests of varieties of plants to special experiments in the management of farm or horticultural crops, live stock, or particular operations, such as tobacco curing. It is coming to be more clearly recognised that the field operations in agriculture or horticulture conducted on the station farm need to be supplemented by similar work in a considerable number of localities in order to be of general usefulness to the State. By going into different localities, as the needs of its work demand, the station can make itself more useful to the State as a whole. Without doubt cooperative experiments need to be very carefully planned and thoroughly supervised to be successfully conducted, and their success depends on their quality rather than their number. It is encouraging to observe that more careful attention is being given to this important matter by station officers, and it is believed that this work may be made much more economical and useful than the permanent substations as ordinarily managed.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In consequence of the death of Sir John Conroy, a tutorial fellowship in chemistry and physics, to be held in conjunction with the Bedford Lectureship, is announced at Balliol College. The fellow elected will be expected to supervise the whole science teaching of the College and to give instruction in chemistry and elementary physics. Applications, with the names of three persons to whom reference may be made, must be sent to the Master on or before April 18.

Profs. E. A. Minchin and A. Sedgwick have been appointed public examiners in zoology.

Scholarships in natural science are announced for June 18 at Merton College, New College, and non-collegiate students.

CAMBRIDGE.—The Smith's Prizes are awarded to Mr. G. H. Hardy and Mr. J. H. Jeans, of Trinity College. Mr. P. V. Bevan, of the same College, receives honourable mention. The prizemen were second and fourth wranglers respectively in 1898. Mr. Bevan was fourth wrangler in 1899.

Mr. L. Doncaster, of King's College, is nominated to the University table at the Naples Zoological Station.

Miss Meyer has presented to the Geological Museum the valuable collections made by her brother, the late Mr. C. J. A. Meyer.

THE senate of Glasgow University has resolved to confer the honorary degree of LL.D. upon Prof. A. W. Rücker, Sec. R.S., at the graduation ceremony on April 23.

THE council and senate of University College, Liverpool, has passed a resolution "that any measure dealing with the organisation and control of secondary education should provide for the direct representation of Universities and University colleges in the local authorities which such Bill may establish."

THE chair of natural philosophy in the University of Edinburgh will become vacant on April 29, in consequence of Prof. Tait's resignation. The patronage of the chair is vested in the curators. Applications, with relative testimonials, should be lodged with Mr. R. Herbert Johnston, secretary to the curators, at 4, Albyn Place, Edinburgh, on or before June 1.

THE annual general meeting of the Association of Technical Institutions, adjourned in consequence of the death of the Queen, will be held at the Fishmongers' Hall, London, on Tuesday, April 16, when the president, Sir Swire Smith, will take the chair and the president-elect, the Right Hon. Sir William Hart Dyke, M.P., will deliver an address.

FROM the ninth annual report of the Technical Instruction Committee of the City of Liverpool we derive the following facts as to valuable scientific instruction and work assisted by the committee. A course of four lectures was given on "Electric Vibrations," by Prof. O. J. Lodge, F.R.S., and a course of five lectures on "Oceanography," by Prof. Herdman, F.R.S. Both courses proved very successful in achieving the main object for which they were designed, viz., to bring before teachers of schools and classes some of the results of the progress of modern science, and to illustrate the methods and lines upon which this progress is proceeding. Admission to the courses was free to teachers of schools and classes in Liverpool. In 1900 the committee again renewed their grant (of 100*l.*) in aid of the scientific work carried on by the Lancashire Sea Fisheries Joint Committee. A permanent Sea Fisheries Laboratory in the Zoological Department of the University College, under the direction of Prof. Herdman, is partly supported by this grant; and trained assistants are constantly at work in this laboratory investigating fisheries' questions that may arise in

connection with the local industries. One of the rooms of the Zoological Museum at the University College of Liverpool is devoted to a permanent fisheries collection, illustrating the local fishing industries. The committee has thus proved that success attends the co-operation of the work of men of science in University Colleges with that of technical instruction, and their action should lead to the development of a similar policy in other cities.

SCIENTIFIC SERIALS.

Symons's Meteorological Magazine, February.—The pressure of the wind, by R. H. Curtis. In this paper the author deals with the wind-pressure from the point of view of the engineer and its effect upon structures, rather than from a purely meteorological standpoint. After the time of the collapse of the Tay Bridge, in December 1879, a good deal of attention was paid to this subject, and a committee was appointed to consider the question of wind force on railway structures. It estimated that the greatest pressure likely to be experienced over a large surface was 56 lbs. per square foot, but that, to ensure safety, bridges and similar structures ought to be built to withstand four times that pressure. This conclusion has probably led to an extravagant expenditure of money, as the records of improved and well-exposed anemometers have recently shown that this estimated pressure of 56 lbs. was greatly in excess of anything likely to be experienced. It is true that an Osler's pressure anemometer at Liverpool Observatory registered the extraordinary pressure of 90 lbs. on the square foot in March 1871. But this exaggerated record must have been due to a succession of impulses upon the pressure plate, as a wind force of less than 60 lbs. per square foot would, in all probability, have sufficed to carry away the anemometer itself. The author has paid much attention to this subject and will continue his interesting discussion.—Weather records at Slough, by Mr. R. Bentley. Instrumental observations were begun there by Sir William Herschel in the latter part of the eighteenth century. Mr. Bentley communicates classified rainfall values for 1874–1899, and has collected non-instrumental records of interesting phenomena in South Buckinghamshire from a very remote period.

American Journal of Science, February.—Apparent hysteresis in torsional magnetostriction and its relation to viscosity, by C. Barus. A differential method is employed, in which the two identical wires of iron or nickel to be compared are fastened coaxially one above the other, a mirror being attached between them. Accidental temperature effects are avoided by keeping the lower wire submerged in a tube of flowing water. A current can be sent either round or through the wire, so as to place the wire in either a longitudinal or circular field, the effect to be observed showing itself in a shifting of the fiducial zero. The phenomena are independent of the direction of the current and a larger angle of twist does not appear to magnify them. The results, which are somewhat complex, can be understood if magnetisation be regarded as a means of shaking up the molecular mechanism, and thus to produce temporary molecular instability or momentarily very low viscosity.—The dinosaurian genus Creosaurus, Marsh, by S. W. Williston. A description of a shoulder girdle and arm of a carnivorous dinosaur obtained from a deposit in the Freeze Out Mountains, Wyoming. The fossil is well differentiated from Allosaurus, although occurring with remains which may possibly belong to that genus.—The stereographic projection and its possibilities from a graphical standpoint, by S. L. Penfold. A continuation of a previous paper. The graphical methods are applied to some solutions of spherical triangles, in determining geographical distances, and to map projection.—On the melting point of gold, by L. Holborn and A. L. Day. These results have been already noted in the January number of *Wiedemann's Annalen*.—On some new mineral occurrences in Canada, by G. Chr. Hoffmann. The minerals described are lepidolite, newburyite, struvite, schorlomite, danalite, spodumene and uranophane.

Bulletin of the American Mathematical Society, February.—The seventh annual meeting of the Society was held in New York City, on December 28, 1900. Several important changes in the organisation of the Society were made, the membership of which has now reached the fine total of 357 names. Prof. F. N. Cole gives a brief recapitulation of advance since the foundation of the Society, and fully records the proceedings at the Christmas gathering. The titles of seventeen papers are given and abstracts of many of them are here printed. On some birational transformations of the Kummer surface into itself, by Dr. J. I. Hutchinson, is a paper read at the meeting. Another paper that was read is entitled "Theorems concerning positive definitions of finite assemblage and infinite assemblage," by C. J. Keyser. A third paper, by W. B. Ford, is entitled "Dini's method of showing the convergence of Fourier's series and of other allied developments." Short notice follows of Fehr's Application de la méthode vectorielle de Grassmann à la géométrie infinitésimale, by E. B. Wilson, and of the Annuaire pour l'An 1901, publié par le Bureau des Longitudes, by Prof. E. W. Brown. Notes and new publications as usual.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 21.—"An Investigation of the Spectra of Flames resulting from Operations in the Open-hearth and 'Basic' Bessemer Processes." By W. N. Hartley, F.R.S., Royal College of Science, Dublin, and Hugh Ramage, A.R.C.Sc.I., St. John's College, Cambridge.

Three papers on "Flame Spectra," by one of the authors, were published in the *Philosophical Transactions* for 1894. Parts I. and II., "Flame Spectra at High Temperatures," and Part III., "The Spectroscopic Phenomena and Thermochemistry of the Bessemer Process."

The spectroscopic results were quite different from those previously obtained by observing the "acid" process, as the continuous spectrum was much stronger. Many lines and bands new to the Bessemer flame spectra were observed.

Twenty-six plates of spectra were photographed. The spectra increase in intensity as the blow proceeds in the first stage, and this can only result from a corresponding increase in the temperature of the bath of metal and of the flame.

Considerable difficulty was experienced in the identification of some of the lines and bands; some were due to uncommon elements, and others were relatively much stronger than a study of the oxyhydrogen flame and other spectra of the same metals had hitherto shown.

Conclusions.

(1) Line spectra are not observed in the open-hearth furnace. This is attributed mainly to the fact that the atmosphere of the furnace is oxidising, and under these conditions, as Gouy has shown (*Phil. Mag.*, vol. ii., 1877, p. 156), only sodium gives a spectrum approaching in intensity that which it gives in a reducing flame.

(2) The phenomena of the "basic" Bessemer blow differ considerably from those of the "acid" process.

First, a flame is visible from the commencement of blowing. The immediate production of this flame is caused by carbonaceous matter in the lining of the vessel, its luminosity is due partly to the volatilisation of the alkalies, and to the incandescence of lime dust carried out by the blast.

Secondly, volatilisation of metal occurs largely at an early period in the blow, and is due chiefly to the smaller quantity of silicon present.

Thirdly, a very large amount of fume is formed towards the close of the second period. The flame is comparatively short, and the metallic vapours carried up are burnt by the blast.

Fourthly, the "over blow" is characterised by a very powerful illumination from what appears to be a brilliant yellow flame: a dense fume is produced at this time composed of oxidised metallic vapours, chiefly iron. The spectrum is continuous, but does not extend beyond wave-length 4000. The light emanates from a torrent of very small particles, liquid or solid, at a yellowish-white heat.

Fifthly, the spectra of flames from the first stage of the "basic" process differ from those of the "acid" process in several particulars. The manganese bands are relatively feeble, and lines of elements, not usually associated with Bessemer metal, are present. Lithium, sodium, potassium, rubidium and cæsium have been traced mainly to the lime used; manganese, copper, silver and gallium to the metal.

(3) Differences in the intensity of metallic lines. The intensity of the lines of any metal varies with the amount of the metal in the charge, but they are also to be traced to changes in temperature; as the temperature of the flame rises, some lines

fade almost away, others become stronger. The changes are more marked in the arc spectrum and still more in the spark spectrum of iron.

A new line of potassium with variable intensity. This line, wave-length approximately 4642, varies in intensity within somewhat wide limits. In a given flame its brilliancy is increased by diminishing the quantity of metallic vapour in the flame: this does not appear to depend altogether on the weakening of the continuous spectrum; it is probably due, in part at least, to the increased freedom of motion permitted to the molecules of the metal.

February 21.—"Notes on the Spark Spectrum of Silicon as rendered by Silicates." By W. N. Hartley, F.R.S.

March 7.—"On the Composition and Variations of the Pelvic Plexus in *Acanthias vulgaris*." By Mr. R. C. Punnett, B.A., Gonville and Caius College, Cambridge. Communicated by Dr. H. Gadow, F.R.S.

"Preliminary Communication on the Œstrous Cycle and the Formation of the Corpus Luteum in the Sheep." By F. H. A. Marshall, B A. Communicated by Prof. J. C. Ewart, F.R.S.

Physical Society, March 8.—Dr. R. T. Glazebrook, foreign secretary, in the chair.—A paper on a theory of colloidal solutions was read by Dr. F. G. Donnan. Assuming that a colloidal solution is not a true molecular intermixture, but a two-phase system consisting of exceedingly minute aggregates of the colloid distributed throughout the solvent, the object of the paper was to examine how such a state of affairs might be imagined to come about. By applying the fundamental notions of Laplace's theory of capillary forces to the statical (mechanical) equilibrium at the interface, it was shown that under certain conditions matter in bulk might disintegrate into a homogeneous liquid medium and yet not attain a state of molecular division, remaining distributed in the form of very thin filaments or sheets whose thickness is comparable with the sphere of molecular attraction. True solution, or molecular intermixture, is regarded, on the other hand, as arising from the kinetic flux of molecules across the interface. Dr. Gladstone said that the study of colloids was one which had been too much neglected. It involves both a knowledge of physics and of chemistry. A colloid is an unstable body and is always altering its composition. Water of combination is given off on heating, even if the surrounding atmosphere is saturated, and the colloid cannot take up the water again. It is impossible to separate colloids and crystalloids—they merge into one another. The transition forms are not uncommon. Dr. Lehfeldt asked if it had been proved that colloids have osmotic pressure. Prof. Threlfall said that in colloidal solutions some of the substance was not in suspension. Dr. Martin had filled a filter with silicic acid under pressure, and found that it allowed sugar solution to pass through but stopped colloidal solutions. The author had used opacity as a test for colloids, but silicic acid could be got transparent. There are two kinds of opalescence—one cannot be removed and exists because the substance is a two-phase system; the other can be removed with difficulty by filtering, and leaves a transparent substance. The want of transparency should be used cautiously as an argument. Dr. Donnan, in reply to Dr. Gladstone's remarks on the transition from crystalloids to colloids, said that a substance might be a crystalloid with one medium and a colloid with another. In reply to Dr. Lehfeldt, he said that the only evidence in favour of osmotic pressure of colloids is that colloidal solutions diffuse. He agreed with Prof. Threlfall that opacity should be used carefully as an argument, but stated that his theory referred to a two-phase system. —Mr. Appleyard then exhibited three pieces of apparatus. The first was a slide wire bridge for measuring conductivities of wires. The slide wire instead of forming two arms of the bridge forms only one, and the length used is proportional to the conductivity to be measured. If the arm which contains the standard wire used is altered, it becomes necessary to alter the divisions of the scale on the slide wire. This is done by a mechanical arrangement. The second piece of apparatus was a mechanical gauge for measuring the diameters of spheres. The sphere to be measured is placed between a metal face plate and a piece of glass at the end of the short arm of a pivoted lever. The end of the long arm of the lever moves over a graduated scale which is calibrated to show directly the diameter of the sphere. The third piece of apparatus was a galvanometer fitted up for lamp and scale work. The illumination was produced by a 4 volt ½-candle power lamp, and it was shown that very good results could be obtained from this by using a large condensing lens. Prof. Threlfall said he had usually used a straight piece of the lamp filament itself, instead of using the lamp in conjunction with a cross wire.—A paper, by Prof. R. W. Wood, on the production of a bright line spectrum by anomalous dispersion and its application to the flash spectrum, was postponed until the next meeting at Burlington House, when the subject will be experimentally illustrated by Mr. Watson.—The Society then adjourned until March 22, when the meeting will be held in the chemical laboratories of University College, London.

Geological Society, February 15.—Annual General Meeting.—J. J. H. Teall, F.R.S., president, in the chair.—It was stated that, the Council having undertaken to supply to the Regional Bureau of the International Catalogue of Scientific Literature the material referring to geology published in the British Islands, Mr. C. Davies Sherborn had been appointed to prepare and edit the catalogue-slips necessary for that purpose. The reports having been adopted, the medals and funds of the Society were awarded as already announced (p. 402).—The president then proceeded to read his anniversary address, in which he first gave obituary notices of several Fellows and Foreign Members deceased since the last annual meeting. He then dealt with the evolution of petrological ideas during the nineteenth century, especially as regards the igneous rocks. The discussions as to the origin of basalt and granite were referred to, and it was shown that the controversy regarding the latter rock had contributed largely to the clearing up of our ideas as to the nature of plutonic phenomena. The solution-theory propounded by Bunsen was especially emphasised, and its modern developments were briefly sketched. It was suggested that the next great advance will, in all probability, be the result of experiment, controlled by the modern theory of solutions, and carried out for the purpose of testing the consequences of that theory and discovering the modifications which may be necessary to adapt it to igneous magmas. The bearing which recent work on alloys had on petrographical problems was also referred to. The problem of the origin of petrographical species was next considered, and the growth of ideas on the subject briefly sketched. It was pointed out that although magmatic differentiation is accepted by many as an important factor in producing different kinds of igneous rocks, it does not rest on any assured experimental basis. Differentiation dependent on, or connected with, the crystallisation of definite minerals was reviewed more favourably; but it was pointed out that all theories of differentiation which are based on unaided molecular flow are subject to the criticism that the time required to effect any important differentiation appears to be too great. Reference was also made to recent work on the modification of igneous magmas by the inclusion and assimilation of rocks through which they pass; and the conclusion was reached that the origin of species, so far as igneous rocks are concerned, is a problem the final solution of which has been handed on by the nineteenth century to its successor.

Royal Astronomical Society, March 8.—Dr. J. W. L. Glaisher, F.R.S., president, in the chair.—Lantern slides were exhibited of photographs of the region of the new star in Perseus, taken by Mr. Stanley Williams. One, taken on February 20, only twenty-eight hours before its discovery, showed no trace of the Nova, though containing stars to about the twelfth magnitude.—Dr. Lockyer showed photographs of the spectrum of the new star, taken at South Kensington. The spectrum showed dark lines of hydrogen, and also broad, bright hydrogen bands displaced towards the red, apparently indicating two sources of light and enormous relative velocities. The spectrum showed the existence in the star of hydrogen, calcium, iron, &c.—Mr. McClean exhibited an enlargement from his photograph of the spectrum, in which he could find no trace of helium. The spectrum of the Nova resembled that of Sirius, but with bright bands of hydrogen; it was also much like that of Nova Aurigæ.—A photograph of the spectrum taken at Stonyhurst was also shown.—Mr. Newall exhibited and explained his photographs of details of the spectrum, taken at Cambridge.—Dr. Rambaut gave results of observations made at Oxford. The colour of the Nova was first of a bluish-white, becoming redder as it diminished in light.—The Astronomer Royal showed photographs taken at the Royal Observatory, where observations were made of the magnitude, which showed a gradual but not perfectly regular, diminution of brightness from 0·5 magnitude on February 25 to 3·1 magnitude on March 6.—Mr. Bellamy brought forward a series of measures

of the position of the Nova, from a photograph taken at the University Observatory, Oxford.—Mr. Bryan Cookson gave a description, illustrated with lantern slides, of a new photographic zenith telescope, constructed with a view to the determination of the constant of aberration. The essential feature of the ordinary zenith telescope is the *level*, but in this new form of the instrument there is no level, verticality of the axis being obtained by floating the supports of the telescope in a bath of mercury. Mr. Cookson also gave some preliminary results obtained with the new instrument.—Nine other communications were taken as read.

Linnean Society, February 21.—Dr. A. Günther, F.R.S., vice-president, in the chair.—Mr. R. Morton Middleton exhibited and made remarks on a series of Virginian oysters of certified ages.—Mr. H. E. Smedley exhibited with the aid of the lantern a series of photomicrographs illustrating the histology of various types of plants. Mr. Smedley also showed some fossil remains of *Balaena* from the Crag, with other undetermined bones.—A paper by Prof. E. Ray Lankester, F.R.S., and Mr. R. Lydekker, F.R.S., on the affinities of *Ælluropus melanoleucus*, was read by Mr. Lydekker. The authors based their views on an examination of a cast of the skull presented by the late Prof. Milne-Edwards to the Oxford University Museum, and certain limb-bones and a fine skull in the Natural History Museum, South Kensington, all of which were described. The conclusions arrived at were that in important and distinctive points *Ælluropus* agrees with *Ælurus* and *Procyon* (more closely with the former) and differs widely from *Ursus*, notwithstanding its external resemblance to the last named. The salient points in the anatomy of each were discussed, and the resemblances and differences made clear by a series of photographs which were exhibited.—A paper by Monsieur A. Gruvel, entitled "Étude d'une espèce nouvelle de Lepadides," was communicated by Prof. Howes, who gave an abstract of the same, and exhibited drawings of the new species (*Scalpellum maximum*) described by the author. The paper also dealt with examples of *Poecilasma carinatum* which were found attached to a specimen of the *Scalpellum*.

Anthropological Institute, February 25.—Prof. Haddon, F.R.S., president, in the chair.—Mr. H. Ling Roth read a paper on Maori tatu and moko. The paper, which was fully illustrated by lantern slides, opened with an explanation of the difference between tatu and moko; by the former is understood production of a pattern by puncturing the skin and depositing colouring matter under it; in the final state the skin is perfectly smooth. In moko, on the other hand, the instrument is a chisel and leaves slight grooves in the skin after the wound is healed. The Maoris made use of spirals and coils in their patterns, differing in this respect from other Polynesians. The instrument, which is really a miniature hoe, is placed on the skin and tapped with a mallet. The operation is extremely painful, involving great loss of blood, so that only a small portion of the pattern can be done at once. The portions of the body operated on are the face and thighs, and in the case of the latter the effect is that of an ornamental pair of drawers. The operation was begun at puberty and small additions were continually made, especially after a successful fight or on similar important occasions. The most elaborately tatued was most favoured by the fair sex. In some cases post mortem moko was employed to increase the value of a specimen.—Major-General Robley presented a drawing of a Maori war dance.

EDINBURGH

Mathematical Society, March 8.—Some elementary theorems regarding surds, by Prof. Chrystal.—Note on the application of complex integration to the equation of conduction of heat, by Mr. John Dougall.

PARIS.

Academy of Sciences, March 4.—M. Fouqué in the chair.—On the new star which recently appeared in the constellation of Perseus, by M. J. Janssen. In stars such as the sun, in which the temperature is too high for water to exist, as the temperature falls there must come a point at which combination of the hydrogen and oxygen will suddenly take place. This would be accompanied with an enormous and sudden increase of temperature and hence of light production, and this is put forward as a possible explanation of the appearance of a new star. At the moment of combination, on account of the pressures and temperatures developed, the rays of the spectrum ought to be considerably enlarged, and this is precisely what appears in the spectra obtained at Meudon.—Meridional sight with cylindrical mirror, by M. G. Lippmann. A description of an apparatus for measuring right ascensions, in which the meridian is shown as a luminous line projected upon the sky. With this apparatus a cross wire in the eyepiece is rendered unnecessary.—On the preparation and properties of sulphammonium, by M. Henri Moissan. The three varieties of sulphur were submitted to the action of liquefied ammonia at $-80°$ C.; no reaction takes place, but on allowing the temperature to rise slowly solution occurs with sulphur insoluble in carbon bisulphide at $-38°$, with prismatic sulphur at $-15°.5$, and with the octahedral variety at $-11°.5$. From this solution a new compound, sulphammonium, can be obtained, of a dark red colour, and having at $-23°$ the composition $(NH_3)_2S$, at $20°$, $(NH_3)_2S.2NH_3$, which is completely dissociable at the ordinary temperature and pressure, and which possesses the property of being able to add sulphur in the cold to a large number of simple and compound bodies.—A method of estimating sulphides, sulphydrates, polysulphides and hyposulphites coexisting in solution, in particular in certain mineral waters, by M. Armand Gautier. The method proposed is based upon the facts that sulphhydrates, distilled in a vacuum, give up all their sulphuretted hydrogen in excess of that required to form the monosulphide, and this, again, yields the whole of its sulphur on distilling in a current of carbon dioxide. Test analyses are given of a water prepared synthetically and of the mineral water of Labassère.—On germination in distilled water, by MM. P. P. Dehérain and Demoussy. Seeds can form their roots and commence their development in distilled water absolutely deprived of lime, although this development is arrested when the distilled water contains unweighable traces of copper.—A phototherapic apparatus without a condenser, by MM. Lortet and Genoud. The size of the active zone in the apparatus described may be varied from 1 to 6 cm. in diameter, the zone from an apparatus using a condenser being much smaller. The time necessary for the exposure is also reduced to one-fourth of that required in the older form of apparatus.—Observations on the brightness of the planet Eros made at the Observatory of Lyons, by MM. Guillaume, Le Cadet and Luizet. The results are shown in the form of a curve having a period of about 2h. 50m., the total variation of light being about two magnitudes.—On the variation of brightness of the planet Eros, by M. M. Luizet. A mathematical discussion of the results of the previous paper.—Variations of brightness of the planet Eros, by M. Baillaud. From observations made at the Observatory of Toulouse, the period between the times of maximum brightness is found to be the same as between the minima, 2h. 23m.—The elements of the system formed by the double planet Eros, by M. Ch. Andre. The time of revolution of the satellite of Eros is nearly that of Phobos, the eccentricity is nearly equal to that of the lunar orbit, and the mean density of the system is of the order of that of Mars.—On the period of the variability of brightness of the planet Eros, from determinations made at the Observatory of Toulouse, by M. L. Montangerand. The period deduced is 2h. 22m.—On the new star in Perseus, by M. M. Luizet. A comparison of the magnitude of the new star with α-Taurus, β-Gemini, α-Perseus, and γ-Cassiopeia.—Observations on the new star in Perseus, by M. H. Deslandres. A detailed study of the spectrum of the new star (see p. 477).—On a certain surface of the third order, by M. D. Th. Egorov.—On complete systems of partial differential equations, by M. Edmond Maillet.—On the propagation of the Hertzian oscillations in water, by M. C. Gutton. It is shown that the wave-length remains the same when the resonator and the transmitting wires are immersed in water.—The law of transparency of matter for the X-rays, by M. L. Benoist.—On the induced radio-activity provoked by radium salts, by MM. P. Curie and A. Debierne. The experiments cited show that the induced radio-activity is transmitted by the air, and this is in agreement with the hypothesis of Rutherford.—On a new method for determining the atomic weight of uranium, by M. J. Aloy. The nitrate is decomposed, and the ratio of nitrogen to uranium nitrate determined.—Thermal study of the ammoniacal aluminium chlorides, by M. L. Baud.—On a new silicide of cobalt, by M. Paul Lebeau. The new silicide, which has the composition CoSi, is obtained by heating metallic cobalt and copper silicide in the electric furnace.—On the mixed organo-magnesium compounds, by M. V. Grignard (see p. 477).—On an isomeride of anethol and on the constitution of the latter, by MM. Behal and Tiffeneau. Anisol, treated

with magnesium-methyl iodide, gives a propenyl anisol and a polymer. The composition of the ketone formed from this on hydrolysis leads to the conclusion that anethol possesses a propylenic chain.—On the phenylhydrazones of glucose and their multirotation, by MM. L. J. Simon and H. Bénard.—A general method for the synthesis of the naphthenes, by MM. Paul Sabatier and J. H. Senderens. At 170° to 200° all the hydrocarbons tried were readily hydrogenised by reduced nickel. Details are given of the preparation of the hexahydro-compounds of toleune, orthoxylene and its meta- and para-isomers, ethyl benzene, mesitylene, pseudocumene and propylbenzene.—The specific and latent heat of fusion of ethylene glycol, by M. de Forcrand.—On the constitution of gentianose, by MM. Ed. Bourquelot and H. Hérissey.—The treatment by oxygen at atmospheric pressure of persons poisoned by carbon monoxide, by M. N. Gréhaut. The elimination and disappearance of the poison is considerably accelerated by the use of oxygen, which thus becomes essential in the treatment of cases of carbon monoxide poisoning.—The analogies between the diastatic actions of colloidal platinum and those of organic diastases, by M. G. Bredig.—The coagulating properties of mucus and its origin and consequences, by MM. Charrin and Moussu.—On a differential histochemical reaction of leucocytes and on the experimental production and the nature of the chromatophile granulations of its cells, by M. Henri Stassano.—New observations on the organisation of the Gasteropods, *Pl. Quoyana* and *Pl. Beyrichi*, by MM. E. L. Bouvier and H. Fischer.—On the different cells of the ovary which intervene in the formation of the egg in insects, by M. A. Lécaillon.—On the mechanism of the propulsion of the tongue in amphibians, by M. Marcus Hartog.—On the geotropism of the roots of the vine, by M. J. M. Guillon.—On the discovery of a glossopterian flora and of the reptiles *Pareiasaurus* and *Dicynodon* in the upper Permian deposits of the north of Russia, by M. V. Amalitzky.—The tertiary and quaternary deposits of the valley of Bellegarde, by M. H. Douxami.

DIARY OF SOCIETIES.

THURSDAY, MARCH 14.

ROYAL SOCIETY, at 4.30.—The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases: C. E. S. Phillips.—The Chemistry of Nerve-degeneration: Dr. Mott, F.R.S., and Prof. Halliburton, F.R.S.—On the Ionisation of Atmospheric Air: C. T. R. Wilson, F.R.S.—On the Preparation of Large Quantities of Tellurium: E. Matthey.

ROYAL INSTITUTION, at 3.—Greek and Roman Portrait Sculpture: Prof. Percy Gardner.

MATHEMATICAL SOCIETY, at 5.30.—On the Composition of Group-Characteristics: Prof. Burnside, F.R.S.—On the Use of Cauchy's Principal Values in the Double Limit Problems of the Integral Calculus: G. H. Hardy.—Some Algebraical Identities of Simple Arithmetical Application: Prof. Elliott, F.R.S.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Growth and Trend of Indian Trade—a Forty Years' Survey: H. J. Tozer.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Notes on Polyphase Substation Machinery: A. C. Eborall.

FRIDAY, MARCH 15.

ROYAL INSTITUTION, at 9.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Combined Trolley and Conduit Tramway Systems: A. N. Connett.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Enteric Fever Mortality in Copenhagen from 1828–1898: Dr. N. P. Schierbeck.—The Effect of Sewerage and Water Supply upon the Behaviour of Enteric Fever in Buenos Ayres: Dr. J. T. R. Davison.

SATURDAY, MARCH 16.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

MONDAY, MARCH 18.

SOCIETY OF ARTS, at 8.—Electric Railways: Major P. Cardew.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—The Topography of South Victoria Land: L. C. Bernacchi.

VICTORIA INSTITUTE, at 4.30.—Religion and Art: Rev. T. Hunter Boyd.

CAMERA CLUB, at 8.15.—Discussion on Panoramic Photography.

TUESDAY, MARCH 19.

ROYAL INSTITUTION, at 3.—The Cell as the Unit of Life: Dr. A. Macfadyen.

ZOOLOGICAL SOCIETY, at 8.30.—On New or Imperfectly-known Ostracoda, chiefly from a Collection in the Zoological Museum, Copenhagen: Dr. G. S. Brady, F.R.S.—On *Lemur mongoz* and *L. rubriventer*: Dr. C. I. Forsyth Major.—On the Hymenoptera collected in New Britain by Dr. Arthur Willey: P. Cameron.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Æsthetic Treatment of Bridge Structures: J. Husband.

MINERALOGICAL SOCIETY, at 8.—Notes on an Occurrence of Minerals at Haddam Neck, Connecticut, U.S.A.: H. L. Bowman.—On Calaverite from the Cripple Creek District, Colorado, U.S.A.: G. F. Herbert Smith.—On the Arrangement of the Chemical Atoms in Boracite and Cassiterite: W. Barlow.

ROYAL STATISTICAL SOCIETY, at 5.—Results of State, Municipal, and Organised Private Action on the Housing of the Working Classes in London and in other Large Cities in the United Kingdom: Dr. John F. J. Sykes.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photographing Stained Glass by the Three-colour Process: Chas. B. Howdill.

WEDNESDAY, MARCH 20.

SOCIETY OF ARTS, at 8.—Evolution of Form in English Silver Plate: Percy T. Macquoid.

GEOLOGICAL SOCIETY, at 8.—On a Remarkable Volcanic Vent of Tertiary Age in the Island of Arran, enclosing Mesozoic Fossiliferous Rocks: B. N. Peach, F.R.S., W. Gunn, and E. T. Newton, F.R.S.—On the Character of the Upper Coal Measures of North Staffordshire; their Comparison with those of Denbighshire, South Staffordshire, and Nottinghamshire; and their Relation to the Productive Series: Walcot Gibson.

ANTHROPOLOGICAL INSTITUTE (Albemarle Street), at 8.—Joint Meeting with the Folklore Society.—Sand Ropes and other Futile Tasks: G. M. Godden.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Climate, and the Effects of Climate: Dr. Hugh Robert Mill.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Metallography of Iron and Steel: Wm. H. Merrett.

INSTITUTION OF MINING AND METALLURGY, at 8.—Annual General Meeting.—Followed by: The Electric Power Station at the Pierrefitte Mine: E. Henry Davies.—(1) Note on Smelting Lead-Copper Ore; (2) Note on Lead Assaying: P. R. Robert.

THURSDAY, MARCH 21.

ROYAL SOCIETY, at 4.30.—Studies in Visual Sensation (Croonian Lecture): Prof. C. Lloyd Morgan, F.R.S.

LINNEAN SOCIETY, at 8.—On the Intestinal Tract of Birds, and the Valuation and Nomenclature of Zoological Characters: P. Chalmers Mitchell.

CHEMICAL SOCIETY, at 8.—Researches on Morphine, Part II: S. B. Schryver and F. H. Lees.—The Constitution of Pilocarpine, Part II.: H. A. D. Jowett.—Note on the Latent Heats of Evaporation of Liquids: Holland Crompton.—(1) Action of Dry Silver Oxide and Ethyl Iodide on Benzoylacetic Ester, Desoxybenzoin, and Benzyl Cyanide; (2) Alkylation of Acylarylamines: G. D. Lander.

CAMERA CLUB, at 8.15.—Yorkshire Caves and Waterfalls: T. C. Hepworth.

FRIDAY, MARCH 22.

ROYAL INSTITUTION, at 9.—Some Recent Work on Diffusion: Dr. Horace Brown, F.R.S.

PHYSICAL SOCIETY (University College, Gower Street), at 5.—On the Expansion of Silica: Prof. Callendar, F.R.S.—The Spectroscopic Apparatus at University College: Dr. E. C. C. Baly.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Hunslet Railway and Bridge over the River Aire: O. L. McDermott.

SATURDAY, MARCH 23.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S

CONTENTS.

THURSDAY, MARCH 21, 1901.

CELTIC TRADITIONS AND ANTHROPOLOGY.

Celtic Folk-lore, Welsh and Manx. By John Rhys, M.A., D.Litt., Hon. LL.D. of the University of Edinburgh, Professor of Celtic, Principal of Jesus College, Oxford. 2 vols., paged consecutively. Pp. xlviii+718. (Oxford: Clarendon Press, 1901.) Price 21*s*.

PROF. RHYS has done well to republish, in these two handsome volumes, the collections of Celtic Folk-lore contributed by him to the pages of *Y Cymmrodor* and the *Transactions* of the Folk-lore Society. For not only are they thus rendered accessible to a larger number of readers, but he has enriched them with considerable additions, and a valuable commentary. Had he seen his way to recast the original articles, with a view to a more complete classification of their contents, it would have avoided some repetition, and would have set the relations of the various tales in a clearer light. But we must be grateful for the work in its present form. To recast the articles would have been a troublesome process, and perhaps no classification would have been entirely satisfactory. Moreover, we should certainly have missed in any such rearrangement much of the genial charm of the collections as they first came from his pen, derived from the personal narrative of the collector. To a large number of his readers this would have been a sacrifice they might not be willing to make, even for the sake of theoretical order. When, however, the severely virtuous student, who, intent only on what he is to learn, would have preferred to make this or any other sacrifice, has calmed his ruffled feelings and settled down to his task of learning, he will speedily realise how important a contribution to anthropology, and in particular to Celtic archæology, he has before him.

The chief intent which runs through the commentary is to determine so far as possible the race-elements that have gone to fashion the composite people of Wales, now so thoroughly welded together in historical memories and in political, religious and artistic aspirations. To this Prof. Rhys makes the whole of his collection subservient. Though he modestly disclaims the title of "folk-lorist," no living man has probably so wide a knowledge of the folk-lore of his native country, and certainly none has brought to its elucidation a scholarship so profound. His open-mindedness and candour are as remarkable as his scholarship. Consequently the present work is greatly in advance of his Hibbert Lectures as an exposition of the origin and real meaning of Celtic traditions. His theory, as summed up in the final chapter, is that in these traditions we have traces of at least two pre-Celtic races: first, a dwarf population inhabiting underground dwellings, and at a level of civilisation no higher than that of the present-day inhabitants of Central Australia; and secondly, the enigmatical people over whom Monkbarns and his guest fought with so much vigour, the Picts, "whose affinities appear to be Libyan, possibly Iberian." That a dwarf race was widely spread over this island cannot be questioned. Whether the bee-hive huts of Scotland and Ireland belonged to them is not quite so certain. In Roman times, and in the south of what is now England, they occupied ordinary wattle-and-daub huts. Prof. Rhys attributes wholly or partially to them birth-stories like those of Cuchulainn and Etain, of which the chief characteristics are virgin-birth and re-incarnation. He acutely points out that in the Cuchulainn story we have "two social systems face to face in Ulster," one of which recognised fatherhood, while the other did not. But alike the story-incidents and the corresponding superstitions are known practically all over the world. It is therefore impossible to fix the dwarf-race with responsibility for them. Besides, upon his own showing, the social organisation of the Picts was founded upon mother-right, and it is to the Picts that Scottish tradition assigns the mounds as dwellings.

In my opinion folk-lore seldom yields trustworthy evidence of race. What it does yield is evidence, often of the most decisive weight, of social states, of belief and practice. That the Welsh are descended from a people who were organised on the basis of mother-right, and believed in transformation, Prof. Rhys has rendered fairly certain from the traditions embodied in their literature, or found by himself in the mouths of the peasantry. Whence the organisation and belief in question were derived must be discovered, if at all, from evidence of another kind, that is to say, from philology and archæology. With the aid of his rare philological learning the author has illuminated many a dark place in the *Mabinogion* and in the folk-tales, though he has failed to solve the riddle which would, perhaps, tell us more of the origin of the fairies and of the descent of the Cymric people than any other incident in the stories, namely, the riddle of the non-Welsh names Penelope, Belene and others attributed to the fairy heroines of so many Welsh tales.

If, however, the folk-tales of the present day fail to yield sure evidence of race, some of those embodied in the *Mabinogion* do. But it is to be obtained rather in the names than in the incidents. It is common ground, for example, between Welsh and Irish Celticists, that there is a Goidelic element in the *Mabinogion*. The question is whether the stories were imported ready-made from Ireland, or grew on the soil of Wales and were adopted and adapted by the Cymric-speaking Celts from the Goidelic and Goidelised peoples they found in occupation of the country when they invaded it. The chapter on place-name stories (and in particular Prof. Rhys' analysis of the Hunting of the Twrch Trwyth) has gone far to settle this question. It must now be held, as the better opinion, that the *Mabinogion* stories which point most strongly to Irish influence, or indeed Irish origin, were taken over from the Goidelic substratum of the nation.

It would be easy to linger on many a delightful page of these fascinating volumes. Prof. Rhys always writes with humour. His gravest discourses are tempered with a smile. But, for all that, they are none the less grave in purpose. He has done more than any other man to rouse in his fellow-countrymen an intelligent interest in their history, language and literature. In conjunction with Mr. Brynmor Jones he has placed the study of Welsh history and institutions at last on something like a sound basis. So here he begins by laying down the maxim that—

"the history of no people can be said to have been written so long as its superstitions and beliefs in past times have not been studied; and those who think that the legends here recorded are childish and frivolous, may rest assured that they bear on questions which could not themselves be called either childish or frivolous."

Further on he returns to the subject:

"With regard to him," he says, "who looks at the collecting and the studying of folk-lore as trivial work and a waste of time, I should gather that he regards it so on account, first perhaps, of his forgetting the reality their superstitions were to those who believed in them; and secondly, on account of his ignorance of their meaning. As a reality to those who believed in them, the superstitions of our ancestors form an integral part of their history. However, I need not follow that topic further by trying to show how 'the proper study of mankind is man,' and how it is a mark of an uncultured people not to know or care about the history of the race. So the Roman historian, Tacitus, evidently thought; for, when complaining how little was known as to the original peopling of Britain, he adds the suggestive words *ut inter barbaros* 'as usual among barbarians.' Conversely, I take it for granted that no liberally educated man or woman of the present day requires to be instructed as to the value of the study of history in all its aspects, or to be told that folk-lore cannot be justly called trivial, seeing that it has to do with the history of the race—in a wider sense, I may say, with the history of the human mind and the record of its development."

There are many scientific men who need to lay to heart this protest.

A full index is given, and a most useful bibliographical list of references. E. Sidney Hartland.

ALKALOIDS.

Die Pflanzen-Alkaloide. By Jul. Wilh. Brühl, Professor in the University of Heidelberg, and Eduard Hjelt and Ossian Aschan, Professors in the University of Helsingfors. Pp. xxii+586. (Brunswick: Friedrich Vieweg und Sohn, 1900.) Price Mk. 14.

THE progress that has been made in the rapidly developing fields of organic chemistry can be best estimated when recognised authorities, such as the authors of the present volume, furnish chemists with special monographs dealing with those groups of compounds in which the writers can lay claim to an expert knowledge. As a class the vegetable alkaloids, which are dealt with in this volume, are of exceptional interest, not only on account of their wide distribution as natural products, but also because of their remarkable physiological actions. It is interesting to note, in reading through this admirable summary of the existing state of knowledge in this branch of chemistry, what great strides have been made towards a more definite conception of the structure or "constitution" of the molecules of these compounds within the last few years. At the present time, the synthetical achievements in this field are not numerous. The first complete synthesis of an alkaloid was that of coniine by Ladenburg in 1886, followed soon after by the synthesis of trigonelline by Hantzsch and Jahns. The latter chemist succeeded in synthesising arecoline in 1891, and the synthesis of piperine from piperidine and piperic acid by Ladenburg and Scholtz in 1894 may be said to complete the list of total syntheses thus far accomplished. But several partial syntheses have to be recorded, viz. aconitine from aconine and methyl benzoate, cocaine from ecgonine and benzoic anhydride; and one step towards the synthesis of hydrastine was made in 1895 by Fritsch.

The effect of this more intimate knowledge of the chemical constitution of the alkaloids is evident in the classification adopted in the present work. It is, in fact, now possible to refer large numbers of these compounds to different groups, each group having a well-known organic base as its parent form. Every one of the four parent compounds, viz. pyrrolidine, pyridine, quinoline and isoquinoline, are, it may be of interest to point out, capable of being completely synthesised. A brief sketch of the mode of treatment will enable our readers to form an idea of the value of this monograph by Prof. Brühl and his colleagues.

The introductory chapter deals with the history, distribution, preparation and properties, modes of decomposition, synthesis, physiological action, detection and estimation, and other general considerations relating to the group as a whole. This is followed by the chapter on the alkaloids of the pyrrolidine group, which comprises the hygrines and cuskhygrine. The second chapter contains an account of the alkaloids of the pyridine group, the latter comprising twelve subdivisions trigonelline, the jaborandi alkaloids, areca alkaloids, conium alkaloids, piperine, chrysanthemine, nicotine, solanum bases such as atropine, hyoscyamine, tropacocaine, madragorine, &c.; the alkaloids of coca, the alkaloids of pomegranate root-bark, sparteine and cytisine. The third chapter comprises the quinoline group, and, although divided into only two subdivisions, is very rich in individual compounds, since it includes the very numerous cinchona alkaloids and those of the plants belonging to the genus *Strychnos.* In the fourth chapter, the authors treat of the alkaloids of the isoquinoline group, comprising more than twenty opium alkaloids, hydrastine and canadine, and the alkaloids of *Berberis* and *Corydalis.*

The four chapters, the contents of which have been briefly referred to, deal with those alkaloids which are susceptible of chemical classification by virtue of our knowledge of their constitution. Whether with the progress of chemical science any or all of these formulæ may not require modification—and many of them are confessedly but tentative—does not affect the main question as to the atomic complexes from which the various alkaloids are derivable, and the reference of a particular alkaloid to any one of the four groups may be looked upon as a definite allocation of the compound with reference to its parent complex, whether the latter is genetically connected with its derivative by actual laboratory processes or whether the connection has only been inferred by indirect methods. The remaining alkaloids, which are distributed through the sixteen subdivisions constituting the fifth and last chapter, are, however, classified botanically rather than chemically, since their chemical constitution is unknown and only empirical formulæ can at present be assigned. Thus we

have alkaloids from cryptogamic plants such as ergotinine, lycopodine and pillijanine, and then following these the alkaloids from twelve families of flowering plants, viz. Coniferæ and Gretaceæ, Liliaceæ, Apocynaceæ, Aristolochiaceæ, Buxaceæ, Lauraceæ, Papilionaceæ, Loganiaceæ, Papaveraceæ, Ranunculaceæ, Rubiaceæ and Rutaceæ. A number of odd alkaloids and a few glyco-alkaloids conclude the work. In some of the numerous alkaloids considered as of unknown constitution, a certain amount of knowledge may be said to have been acquired in the direction of structural formulation. To illustrate this point, consider, for example, colchicine from *Colchicum autumnale*, which is empirically written $C_{22}H_{25}NO_6$. It is known, chiefly through the researches of Zeisel, that this alkaloid is a methyl ester containing four methoxy-groups and one acetamino-group. Its formula thus becomes :—

$$C_{15}H_9(OCH_3)_3\left\langle\begin{array}{l}COOCH_3\\ NH\ .\ COCH_3\end{array}\right.$$

and it is obviously a derivative of a phenolic amino-acid. But the constitution of the hydrocarbon complex $C_{15}H_9$, is still unknown, and the placing of the compound among the alkaloids of unknown constitution is thus justified. It is of interest to note in passing, as an illustration of the richness of this field of plant chemistry, that in this fifth chapter alone more than one hundred alkaloids of unknown constitution, but which are nevertheless definite chemical "individuals," are treated of. It may be further mentioned that under the term glyco-alkaloids the authors comprise compounds such as achilleine, solanine, moschatine and vicine, which split up on hydrolysis into glucose and a base.

A work such as that which forms the subject of the present notice cannot be criticised as a literary production. It belongs to that class of books which, being of the nature of monographs, are absolutely indispensable to all who are interested in the progress of organic chemistry, whether as students, investigators, teachers, pharmacologists or manufacturers. It sums up and presents in a systematised form the achievements of research in this particular field, and as a special work it may be said to have no competitor since, as the authors point out in the preface, the standard works on this subject by Pictet (1891) and Guareschi (1896) are already behind the actual state of knowledge in this domain, the boundaries of which are being extended with such astonishing rapidity. In writings of this class, where chemical compounds are dealt with from the historical point of view as well as from the most recent standpoint, there is often a tendency to spin out the history in wearisome detail. No fault can be found on this score with the authors' treatment; their general histories, as well as their histories of the individual alkaloids, are marvels of succinctness. We have long been in the habit of looking to continental writers for such monographs, and if our own specialists have hitherto failed in contributing such standard works to chemical literature, there is some compensating satisfaction in the present case, since the volume under notice is a special contribution to the German edition of an English work, viz. Roscoe and Schorlemmer's well-known "Treatise on Chemistry." R. MELDOLA.

SOUNDINGS IN THE NORTH ATLANTIC.

On the Results of a Deep-Sea Sounding Expedition in the North Atlantic during the Summer of 1899. By R. E. Peake, M.Inst.C.E. With Notes on the Temperature Observations and Depths, and a Description of the Deep-Sea Deposits in this Area. By Sir John Murray, K.C.B., F.R.S. Pp. 44. (London: John Murray, 1901.) Price 5*s*.

THIS little book, the latest of the "Extra Publications" of the Royal Geographical Society, ought effectually to attain at least one of its main objects, which is "to call attention to the assistance that Telegraph Cable Companies render towards improving our knowledge of the character and condition of the ocean's bed." The immense amount of valuable work done at sea every day by the commanders and officers of all kinds of ships deserves far more cordial recognition than it usually receives, especially in this country. The ordinary navigation of a ship involves daily observations of quite as great difficulty and complexity as any in the routine scientific work of a deep-sea expedition, and sailors not only have done, and do, much in the way of special observations of all kinds, but they are able and willing to do more. All they need is to be told what is wanted, and to be encouraged occasionally by satisfactory evidence that their labour is not thrown away. It may be hoped that the inauguration of the British Pilot Chart of the North Atlantic, and the publication of a paper like the present by the Royal Geographical Society, will lead to still fuller recognition of what must probably remain the only available methods of systematic and continuous investigation in ocean meteorology and oceanography.

The expedition here described was sent out to survey routes of cables which the Deutsch-Atlantisch Telegraphengesellschaft and the Commercial Cable Company had decided to lay; the former between Germany, the Azores and New York, and the latter between Ireland, the Azores and Nova Scotia. The preliminary survey was undertaken on the advice of Messrs. Clarke, Forde and Taylor, engineers to the companies. Mr. Peake was responsible for the plan of the survey and the supervision of the operations, and the work was carried out by the Telegraph Construction and Maintenance Company's s.s. *Britannia*, Captain H. Woodcock. The *Britannia* left England on May 4, 1899, and returned on August 3, having made 477 soundings, from most of which samples of the bottom were obtained, and 150 observations of bottom temperature. A large number of current observations were also recorded. The route is described as follows:—A large number of soundings were first taken between Fayal and Flores, on the Azores bank; next a line from south of Flores to New York; then a line from Cape Canso, Nova Scotia, towards the north of Flores. Different parts of the Azores bank were then surveyed in detail, and a line run to the coast of Ireland; and finally the ship returned to the Azores bank and sounded north-eastward to the mouth of the English Channel.

The results of the expedition are dealt with under four heads—depths, bottom temperatures, currents, and

nature of the bottom. A new map shows the distribution of deposits in the North Atlantic according to recent information, and an inset, based principally on the soundings of the *Britannia*, shows the outline of the Azores bank.

The lines of soundings fall naturally into three groups; those between the Azores and the British Islands, those between the Azores and North America, and those on the Azores bank. In each case new discoveries of interest have been made. On the first line a new depression, with soundings over 3000 fathoms, the "Peake deep," has been found; but the chief feature is the discovery of numbers of shoals rising steeply from over 2000 fathoms to within 1200 and 1400 fathoms of the surface, evidently the summits of submarine cones. The more southerly of the two lines between the Azores and North America revealed the important fact that the "tail" of the great Newfoundland bank extends much farther south than has hitherto been supposed. The *Britannia* has added largely to Thoulet's chart of the Azores bank, but the ground is so irregular that much sounding still remains to be done; the bank is described as being probably "a series of small hills, no doubt due to volcanic action."

The observations of bottom temperature, which were made with thermometers of Six's pattern, consist of two series of parallel lines, one double line between the Azores and the British Islands, and another between the Azores and America. It is pointed out that, on the whole, these observations give temperatures above the mean assumed in the *Challenger* report for this region of the ocean; but as that value is merely the average of the observations existing at the time, the volume of water at different temperatures not being taken into account, the difference may not be due to actual change. On the other hand, the *Britannia* observations show that in each of the double lines the temperatures are different; of the Azores-America line, the more northerly gave the higher readings at depths below 2000 fathoms; of the Azores-Europe line, the more southerly. It is suggested that these differences are due to actual change occurring between the dates of observation, and this view is supported by reference to the different temperatures observed in the south-west Pacific by H.M.S. *Egeria* in 1889 and H.M.S. *Penguin* in 1897. From the observations of H.M.S. *Jackal* in 1893, the writer showed that in the Færoe-Shetland Channel temperature was not constant at depths of at least 400 fathoms, and it was further shown that the variations were due to differences of level in the movements of water. The results of more recent work go to show that the active circulation of the eastern and western Atlantic consists chiefly of stream currents comparatively near the land, developed by the drift movements of the central areas and altogether separated by them. The currents on the eastern side are chiefly caused by the banking up of water from the west-wind drifts, and while most of this water escapes laterally to north and south, there is also a descending movement—hence the high temperatures in the depths. It is known that the horizontal streams are liable to great variations, partly seasonal, partly irregular, and the observations of the *Britannia* seem to prove that the vertical movements undergo corresponding changes. The variations of temperature may be regarded as directly due to movements of water, and therefore as seasonal in only a secondary sense, if at all.

The samples of deposits collected by the *Britannia*, numbering 432, are very fully described by Sir John Murray. The map shows two considerable alterations when compared with that of the *Challenger* report. First, the red clay area is extended northward from the deep water round Bermuda and passes directly into the blue mud south of Newfoundland. This abrupt transition to a terrigenous deposit is accounted for by the great distance to which continental detritus is carried by icebergs. Second, the pteropod ooze region round the Azores is restricted to a smaller area than before, although it is noted that the characters of this deposit are not well marked, and that it is difficult to classify some samples as pteropod or globigerina with certainty. Many samples from moderate depths near the Azores contain fewer pteropods than those obtained from deeper water farther north.

H. N. D.

OUR BOOK SHELF.

Modern Astronomy. Being some Account of the Astronomical Revolution of the last Quarter of a Century. By H. H. Turner, F.R.S. Pp. xvi+286. (Westminster: Archibald Constable and Co., Ltd., 1901.) Price 6*s*. net.

THE Savilian professor is so strongly impressed with the magnitude of the changes which have taken place in astronomical methods during the last quarter of a century that he does not hesitate to describe them as revolutionary. The task which he has set himself in this book is to give a brief review of the present situation, pointing out the nature of the changes rather than giving a complete account of them or of the discoveries to which they have led. The book can thus in no sense be regarded as a reference or text-book, but it may be remarked that elementary explanations have usually been introduced to make the matter generally intelligible.

Several quotations are given as an indication that about 1875 there was a feeling that novelties in astronomical methods or results were no longer to be expected. Such a feeling, if it existed, was certainly premature. New instruments of precision have been invented or erected; telescopes of increased size and novel construction have been made; photography has come to aid the astronomer in numberless ways; astrophysics has become an important branch of the subject, with almost boundless possibilities; and even in mathematical astronomy new methods of treating the lunar and planetary theories have been introduced.

This progress is treated under the four heads, "Modern Instruments," "Modern Methods," "Modern Results" and "Modern Mathematical Astronomy." Occasional overlapping and repetition is the natural outcome of this classification, but the book provides an interesting and fairly connected account of several departments of astronomical work. The treatment of astrophysics, however, leaves much to be desired. There is practically nothing in the book relating to the great advances in our knowledge of the sun as a result of recent eclipse work, and it is especially to be regretted that the evidences of stellar evolution are not more fully set forth. There are other indications of the author's unfamiliarity with the progress of astrophysics; on p. 239, for instance, he states that no supposition allied to that of a revolving companion will explain the variability of stars in clusters, whereas the collisions of revolving swarms of meteorites at periastron explain the light curves completely. For the sake of historical accuracy,

it should have been stated on p. 91 that the original idea of the spectroheliograph was due to Dr. Janssen, who first suggested it at the Exeter meeting of the British Association in 1869. Again, with reference to the first observation of the spectrum of a nebula, it is stated (p. 242) that "it was seen at a glance that the spectrum consisted of a few bright lines," though the observer at first attributed what he saw to some possible derangement of his instrument.

Looking forward, Prof. Turner believes that, among other changes, the transit circle will be gradually superseded by the almucantar for star observations, and by the heliometer for observations of the positions of planets, and in celestial photography he predicts a great future for the portrait lens.

The illustrations, some thirty in number, are of indifferent quality, and that of Eros, on p. 109, is almost unintelligible.

Chemistry an Exact Mechanical Philosophy. By Fred. G. Edwards, Inventor of Atomic Models. Pp. xii + 100. (London: J. and A. Churchill, 1900.)

"THE object of this work is to determine the exact shape of the atoms, to find their relative position in space, and to show that chemical force is purely a function of matter and motion." Further, "the shapes obtained for the different atoms is the subject-matter of a British patent (atomic models) dated 1897." Again, "the conclusions herein deduced (when accepted as true) will form a fitting climax to the discoveries of a century which has produced the atomic theory of Dalton, the theory of heat as a mode of motion, and the discoveries of the correlation of physical forces, and that force, like matter, is indestructible."

For the scientific reader there is little need to add any comments to these quotations. There is, however, always the possibility that an author may have a good idea but an unfortunate way of presenting it, and one does not forget that "the law of octaves" was received with something like ridicule. It is necessary to add, therefore, that a careful examination of the present work, made with every desire to find precious metal in it, has failed to reveal anything that seems likely to aid the advancement of science.

In dealing with the *exact shape* of atoms, the author starts with the assumption that the lightest known element, hydrogen, consists of two tetrahedra placed base to base, and that the atoms of the whole of the remaining elements may be similarly formed by tetrahedra built up symmetrically, every two tetrahedra representing one unit of atomic weight. It is practically impossible, without the models before one, to judge whether there is any outcome from this view of things that compensates in any degree for its arbitrariness and complexity. There can be little question, however, that as a whole the book and its doctrines will not command the serious attention of men of science whose leisure and patience are limited.

A. S.

The Chemists' Pocket Manual. By R. K. Meade, B.S. Pp. vii + 204. (Easton, Pennsylvania: The Chemical Publishing Co., 1900.)

A LARGE amount of information of use to professional chemists is brought together in this pocket book. The tables include almost everything to which occasional reference has to be made in chemical laboratories; and with the formulæ, calculations, physical and analytical methods, should be of service not only to chemists, but also to assayers, metallurgists, manufacturers and students. Among the points worthy of special mention are the applications of graphic methods to conversion tables; and the descriptions of select methods of technical analysis.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Use of the Method of Least Squares in Physics.

THE application of the method of least squares to physical measurements is described in several standard text-books—to wit, Kohlrausch's "Introduction to Physical Measurements" (third edition, 1894), Stewart and Gee's "Elementary Practical Physics" (1885), and others. In none of these is it pointed out that the method *as set forth* offers in certain cases a choice of results, and that the solution is practically unique only if a sufficient number of observations be taken. Nor is any indication given how the method is to be applied when none but a small number of observations is available. Since the method is intended for use only when a high degree of refinement is aimed at, these points are of practical importance.

As illustrating the necessity for examining the matter, we may take the example given by Kohlrausch on p. 13 of the book referred to above. The object is to determine the law connecting the length L and temperature θ of a standard metre bar from the following four observations:—

θ . . . . =	20°,	40°,	50°,	60°
l (the excess over 1 metre) =	·22mm.,	·65mm.,	·90mm.,	1·05mm.

The law deduced is

$$L = 999{\cdot}804 + 0{\cdot}0212\theta.$$

It is not, however, pointed out that the law would be different if the equation connecting x and y, in this case θ and l, were written to begin with in a slightly different form. On the contrary, the above solution is presented as if it were altogether beyond doubt.

In the working of the example as given by Kohlrausch, the equation is written

$$y - ax - b = 0;$$

but if it be written

$$cy - x - d = 0,$$

and exactly the same procedure as that adopted in evaluating a and b be followed in determining c and d, the law thence deduced from the observations becomes

$$L = 999{\cdot}800 + 0{\cdot}0213\theta.$$

It will be seen that the constants in these two laws differ by one in two hundred, or 0·5 per cent., as regards the significant figures; and that from the precisely similar way in which they are obtained, they are each equally entitled to recognition.

In fact, corresponding to the values for a and b usually given, viz.:—

$$a = \frac{\Sigma x\Sigma y - n\Sigma xy}{(\Sigma x)^2 - n\Sigma x^2};\ b = \frac{\Sigma x\Sigma xy - \Sigma x^2\Sigma y}{(\Sigma x)^2 - n\Sigma x^2},$$

there are always another pair of values, giving the second form of the law, viz.:—

$$a' = \frac{(\Sigma y)^2 - n\Sigma y^2}{\Sigma x\Sigma y - n\Sigma xy};\ b' = -\frac{\Sigma y\Sigma xy - \Sigma y^2\Sigma x}{\Sigma x\Sigma y - n\Sigma xy}.$$

The first pair of values corresponds to the supposition that the x measurements are guaranteed correct, and the experimental errors are all confined to the y measurements; and the second pair corresponds to the supposition that the y measurements are correct and the errors are all in the x measurements. The two lines

$$y = ax + b$$
$$y = a'x + b'$$

intersect at the centre of mass of the system of points obtained by plotting the observations.

The question naturally arises: How shall a relatively small number of observations, or a series of observations which are relatively discordant, be made to furnish the best mean result obtainable when no other observations are available?

In order to answer this question, we may recur to the remark above that differences in the result are obtained by writing the equation in different forms. The various forms of the equation correspond to the several directions in which the divergencies of

the plotted observations from the graph of the law are to be considered. For instance, when the equation is written

$$y_1 - ax_1 - b = \delta',$$

the divergence δ' is measured along the ordinate; but when it is written

$$cy_1 - x_1 - d = \delta'',$$

the divergence δ'' is measured in the direction of the abscissa. Now if the divergencies were measured at right angles to the graph, and the sum of the squares were made a minimum, the graph would be the principal axis of inertia of the system of points. This line passes through the intersection of the other pair of lines, and gives a smaller sum of squares than any other line. When the number of points is very great, all three lines become sensibly coincident.

We may conclude, then, that when the observations are numerous and fairly concordant, the method of least squares, applied in the manner commonly taught, will give a practically unique result. But if in any particular case there be any doubt on this point, by reason of the number of observations being small, or the discrepancies between the observations being very great, it would appear to be desirable to find both the lines corresponding to the values of a, b and a', b', given above, in order to test the question. In the event of the difference between the pairs of constants obtained not being negligeable, the proper line to be made use of, in preference to either of the two others found as above, would seem to be the principal axis of inertia.

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The Collection of Material for the Study of "Species."

STRANGELY enough, while the publication of "The Origin of Species" and the research which has been carried on since Darwin wrote his epoch-making work have completely revolutionised the morphologist's conception of what is a "species," nearly all the "systematic" work which is published even at the present day, especially in those branches of biological science where the amateur collector exerts most influence, is based upon the principles founded by Linnæus. These principles, while they were perfectly logical in pre-Darwinian days, are now, however, quite obsolete and out of harmony with the current state of biological knowledge. With a view to bringing scientific practice more into accord with scientific theory, a paper to which I listened at a recent meeting of the Linnæan Society suggested a reform in the present system of species nomenclature. Since, however, the great majority of those who describe "species" are unfortunately not in a position to realise how great indeed is the necessity of some such reform, it will probably not obtain immediate support from the systematists. The average "systematist" still holds the pre-Darwinian view of "species"; and, as the great bulk of the material at his disposal in public and private collections is of little value for the proper study of taxonomy, he quite fails to see how absolutely untenable his position really is. He does not realise how utterly impossible it is in certain groups to assign limits to the variability of "species," and it will never occur to him that two specimens superficially alike in all respects may quite possibly have been evolved along entirely different paths.

It is not my intention here to enter into a discussion as to whether a system of provisional names, such as is suggested by Mr. Bernard, might not be of distinct advantage in at least some branches of zoological inquiry; what I do wish to call attention to now is the necessity, if any decided advance is to be made in the study of taxonomy, for a sweeping change in the present system of collecting material, and in its representation in collections. The following remarks bear particularly upon the case of the mollusca, of which group I have personally most knowledge, but they are, of course, more or less applicable to other branches.

The taxonomist requires as a basis for his investigations to know as exactly as may be the range of variation which those forms in which he is interested experience at the different stations over which they occur. This knowledge is obviously most satisfactorily acquired by personal observation on the spot; but, as this is seldom practicable, the student is in general forced to rely upon material collected by others. Unless this material has been properly collected, the conclusions based upon it are likely to be erroneous; and most of the material available to the student of such groups as the Mollusca is eminently unsatisfactory. Apparently the aim of many conchologists is to represent (?) in their collections the greatest possible quantity of "species," each by a certain definite number—usually three—of "fine specimens." These may be as unlike the ordinary examples of the form as can be; and, whether they are localised or not is of little account, so long as they be fine. If a larger or more brilliantly coloured specimen is obtainable it replaces one of the mystic three.

Large Series necessary.—Little can be known about a species until large series have been examined; yet a collector or museum curator almost invariably prefers a "new species" to a specimen which might lead to a clearer understanding of others already in the collection. Again, in most museums two or three shells, for instance, are considered to amply represent a species. When one has only a few examples under examination it is a fairly simple matter to assign these to so-called species; but the task becomes very different when one comes to deal with a large series, particularly if the specimens are from different localities. In all groups the range of specific variability is very much greater than will be admitted by those who confine their attention solely to museum specimens: in the case of the marine Mollusca, it is often quite easy to select from a large gathering of a single species two or more series which will readily pass as distinct species if the intermediate forms are suppressed. In the past, many "species" have been thus formed; and, if rumour speaks truly, this has sometimes been done quite knowingly, the connecting forms having been carefully destroyed; though more generally it has arisen inadvertently through the study of insufficient material. Again, a museum series, in addition to demonstrating the range of variation of a form, should also illustrate its life-history; but only too frequently an immature individual is regarded by the collector as a "bad specimen" and thrown away as valueless.

Exact Localities.—The most important consideration in a collection is that every specimen shall be accurately localised, and the more minutely the exact locality has been recorded the more valuable will the specimen be for study. At the present day, perhaps, few collectors are satisfied with such records as "Australia" or "America," but such scarcely less vague ones as "S. Africa," "W. Indies," &c., are to be commonly met with; and specimens with inexact localities, or without any record at all, abound in our museums. One unsatisfactory feature about specimens purchased from dealers is that there is a temptation for the dealer to suppress the true origin of his specimens.

Those whose knowledge of species has been derived mainly from museum specimens seldom realise how greatly these species often vary in relation to their environment. Thus, in the case of the marine Mollusca, specimens obtained from the sandy portions of a shore will frequently differ perceptibly from others of the same species collected on the neighbouring rocks or mud. By keeping the series from different stations distinct, the collector will often be surprised at the considerable local variation which his specimens will manifest.

Fossil and Recent Forms.—The treatment of palæontology as a distinct science is one of the greatest obstacles in the way of a proper appreciation of the problems of taxonomy. In most museums, as in our own National collection, the fossil forms of a group are widely removed from their recent allies; and the not unnatural result is that writers on existing species of, say, the Mollusca, seldom make even the slightest reference to fossil members of the group. A true knowledge of the relationships of the living members of any group *can* only be attainable by the study of those forms which have preceded them in the process of evolution; and this research will be greatly simplified when recent and fossil forms can be examined side by side. The comparison of recent specimens with the closely related subfossil ones from the same locality and elsewhere is of most particular importance, but is as yet seldom possible.

The Condition of Specimens.—Among conchologists, and in this respect they are almost the only sinners, insufficient attention is generally paid to the condition of the specimens. The collector of shells too often prefers to gather up the miscellaneous débris of a "shell beach" rather than search for living examples, and unfortunately he is in the habit of founding "species" upon material so obtained. A very large percentage of Molluscan species has been based upon single, dead and unlocalised specimens: what wonder that so many of their names are absolutely worthless?

"*Faking*" *Specimens.*—Any interference with the natural

appearance of a specimen is to be most strongly deprecated, unless, indeed, this has been deliberately undertaken for the express purpose of demonstrating some particular structural feature; yet many collectors are in the habit of making their specimens "look pretty." The conchologist removes the periostracum from his shells, treats them with acid or oil, and conceals any imperfection by aid of a file; the entomologist is said to be not above patching a damaged insect with parts taken from another specimen (not necessarily of the same species); and corals are occasionally provided with artificial bases of plaster of Paris.

The practice in vogue in many museums of mounting small specimens upon tablets is an exceedingly bad one, since it greatly restricts any critical examination; moreover, the specimens are liable to be injured by the cement used.

Collecting a Representative Series of Specimens.—As has been pointed out, scientific research necessitates the examination of large series of specimens exactly representing the form as it occurs at the particular station where the specimens were collected. The field naturalist will most readily ensure that a series shall conform to this condition by collecting every specimen of the form in question which is observed during a certain period of work—five minutes, an hour, a month, according to its abundance and variability. And, in order that small local variations may be rendered evident, the area over which the series is collected must be a small one. If now the whole gathering thus obtained is kept *intact* and unmixed with specimens collected on other occasions or at different stations, it may safely be regarded as fairly representing the species as it occurred at that particular time and place; and it will form a satisfactory basis for comparison with similar series gathered elsewhere and at other seasons. It will probably be urged that this system of collecting is impracticable, as it will entail greater cabinet space. Granted that it may necessitate the provision of more storage room, but is not the usefulness of a collection the only excuse for its formation? And if more space is required it must be provided. However, this objection is not nearly so serious as might be imagined; it is by no means necessary or even desirable that enormous series of specimens should be displayed for exhibition in museum cases or cabinets; all that is required is that they should be stored in such a way as to be easily accessible when wanted for study. Thus in most cabinets much space is occupied by cotton-wool which could readily be filled with specimens without in the least adding to the bulk of the collection. In any case, whatever difficulties may be encountered they will have to be overcome, as only when large series of carefully localised specimens from numerous stations are gathered together in our museums and private collections will it be possible for any really scientific taxonomic work to be accomplished. Until this material is available it is useless to argue over rules of nomenclature and such like, as no satisfactory answer can yet be given to the fundamental question, "What is a species?" S. PACE.

Variations of Atmospheric Electricity.

I ENCLOSE a photograph of the tracings, recording the atmospheric electricity disturbances from January 4 to February 15 inclusive. The records are obtained in the following manner: Two antennæ are used, one vertical 20 metres in length, its lower extremity connected to coherer. The other, 47 metres long, consisting of an ascending vertical portion of 20 metres, also connected below with same pole of coherer, a horizontal portion of 7 metres, and a descending vertical portion of 20 metres, the whole being the shape of an inverted U, going up one side of house, across the top and down the other side. These two antennæ are carefully insulated. The other pole of coherer is connected to earth, in this case to the bottom of a deep well. The coherer closes the circuit of a relay, which in its turn closes the circuit of two electro-magnets, one of which draws up the style and so records a stroke on the revolving drum; the other sets a clockwork apparatus in movement which strikes coherer and so decoheres. The receiver is situated on a hill, overlooking the neighbouring country.

The disturbances seem at times to recur about the same time on successive days, or sometimes after an interval of a day or two. For instance, the first two on the 4th and the first two on the 9th seem to have some connection. Again, the second pair on the 9th seem identical with the first pair on the 10th.

Taking the central group on the 9th, 10th, 12th, 14th, it might be subdivided into two groups, commencing on the 9th with two in each group, reaching its maximum on the 10th, five and seven, and on the 12th reduced to one in each group, finally, on the 14th, only one remaining in the stronger group, that is the one with a maximum of seven.

On February 13 there was one disturbance, on February 14 two, the first of which was at identically the same time as the one of the previous day. It would be interesting to compare the records of several receivers and see how far-reaching these disturbances are, or whether they are purely local phenomena. For this purpose two more receiving stations are shortly to be fitted up in this department. During the period covered by these records there have been no visible or audible signs of thunderstorms, and on many occasions the sky was cloudless, barometer high, thermometer low—28° F. to 36° F.—during the last eight days of February, when there could have been no storms within several hundred miles. E. PELLEW.

Bellevue, Laroin, Pau, Basses Pyrénées, France.

The Selborne Yew-tree.

GILBERT WHITE, in his "Antiquities of Selborne," Chap. v. (Chandos Classics Edition) mentions a male yew growing in the churchyard. He believed it to be some centuries old and states its girth as 23 ft. This afternoon I have, with Mr. Lewis Eynon, remeasured the trunk and find it to be 25 ft. 6 in. The stem of this magnificent tree is squat and rather bulging, and as White mentions its girth as something extraordinary, it is to be presumed that his measurement was made at the point of maximum diameter—about four feet from the ground. This is the height at which our figure was obtained, and we used a steel tape taken right round without regarding irregularities of surface. The increase in girth will be seen to correspond to a radial growth of 4·7 in. in the 120 years or so since White's time. I know not whether recent measurements of this tree have been published, but the fact seems worthy of record.

F. SOUTHERDEN.

75 Barry Road, Dulwich, S.E. March 16.

INJURIOUS CONSTITUENTS IN POTABLE SPIRITS.

AN interesting communication is just to hand, by Sir Lauder Brunton and Dr. Tunnicliffe, upon "Certain apparently injurious constituents of potable spirits." Its appearance now is certainly opportune, since, whatever else we may be interested in, alcoholic beverages are certainly attracting a deal of public attention at the present time. It is further, if not a relief, certainly a change, to learn that something else in alcoholic drinks besides arsenic and selenium may be the cause of mischief, and their removal advantageous. Our mentation just now is rather apt to be over-arsenicated; moreover, from the point of the consumer, the impurities discussed by these workers certainly seem to have one important advantage over arsenic, in that they can be completely removed—that is, removed to the satisfaction of the chemist as well as to that of the pharmacologist.

The subject of whiskey, with which the above monograph is concerned almost entirely, has not received very much attention at the hands of chemists, pharmacologists or dietetic experts, since the publication, in 1891, of the report of the select Committee on British and Foreign Spirits. This Committee directed itself mainly to the question whether compulsory bonding, as practised in Canada, should be adopted in this country, and also whether any restrictions should be placed upon blending, as by, for instance, limiting the name whiskey to the product made from malt, or malt and grain, in a so-called pot-still. The result of the Committee, so far as legislation was concerned, was nil. In the course of the inquiry, however, many interesting pharmacological facts came out, and the present work must be looked upon as a continuation of what may be termed the pharmacology of whiskey. Readers who are interested in the subject are strongly recommended to consult the Blue Book, which contains a mass of most interesting and important information.

Certainly until the appearance of this report, and by many even to-day, fusel oil is regarded as par excellence the injurious constituent of whiskey. This substance, which is a mixture of varying proportions, according to the spirit, of butylic, propylic and amylic alcohols, has apparently been maligned, and is not, at any rate in the proportion in which it occurs in ordinary potable spirits, a source of much danger to the public health. The chief other impurities touched upon at this inquiry were furfural and aldehydes other than furfural. At that time very little was known concerning the action of furfural or the aldehydes, and it is especially in this connection that the monograph before us is of interest.

Although there can be no doubt that it is the ethyl alcohol that causes alcoholic intoxication, it appears that the actual way in which one gets drunk, or gets sober after being drunk, depends largely upon the quality of the liquor partaken of. One of the most important factors in determining the quality is the content of the beverage in question in aldehydes, including furfural, another its content in certain volatile bases.

The source of furfural in the manufacture of whiskey is a class of substances known as pentosans; these are derived from the cellulose of the grain husks, and under the influence of heat, in the presence of acids, are in the wash still converted into furfural. Furfural is present in all pot-still whiskeys, and also obviously to a less extent in those patent still whiskeys which are blended with the real pot-still products to give them the taste of whiskey. Any one can apparently demonstrate for himself quite simply the presence of furfural in whiskey. It is simply necessary to dilute the whiskey and to add to it a few drops of an aniline acetate solution; almost immediately the whiskey becomes rose-coloured and later deep rose, changing to light purple according to the quantity of furfural present.

In addition to furfural there are also present in whiskey other aldehydes. Speaking generally, these bodies are poisonous, or at least irritating; they are for the most part converted in the body into the corresponding acid, and thus tend to diminish the alkalinity of the blood. This individual point is not without interest in that, according to most physicians, any cause tending to render the blood less alkaline favours the occurrence of gouty deposits in the joints.

The experimental inquiry concerns itself more especially with the action of furfural upon animals and man. This substance, according to Sir Lauder Brunton and Dr. Tunnicliffe, gives rise to paralysis of the voluntary muscles, and later to clonic and tonic convulsions. An odd point about these symptoms is their transient nature; immediately after the injection of the drug the animal would fall down completely paralysed, its tongue and lips would become bluish and its breathing slow and convulsive, at other times irregular and rapid; convulsions would then appear, vomiting would occur, and then the animal would begin to recover, being at first dazed but becoming rapidly normal. Two human subjects who were bold enough to take this apparently active poison in the same dose got bad throbbing headache after it which lasted the rest of the day. This latter result brings us to what, from the practical standpoint, is the most interesting part of the research.

We believe it will be generally admitted that one of the commonest results of too free potations in the human subject is a bad throbbing headache, and it appears that the alcohol itself is only partly to blame for this disagreeable sequela. The aldehydes generally, and furfural particularly, play a very active part in the production of these headaches. This appears to be one reason why one is less liable to get a headache after old whiskey, for instance, than after new, or, speaking more correctly, relatively new. One of the effects of maturation upon whiskey is to diminish the amount of furfural and aldehydes which it contains. This effect of maturation can apparently be effected by another means, viz., by distillation of the fresh spirit or of the low wines with phenylhydrazine-sulphonate. By this means the authors were able to obtain an aldehyde-free whiskey, and to watch the effect of it upon animals, comparing it with that of the same spirit before distillation. Their results are certainly interesting. They found that recovery from profound alcoholic, or rather whiskey, poisoning was distinctly different in the two cases. In the case of the original spirit, the animal, during the transition stage from drunkenness to sobriety, was restless, wandering from one part of the laboratory to another, and seemed, generally speaking, remarkably uncomfortable. Even when the gross symptoms of alcoholic poisoning had passed off the animal did not behave normally for some time; it refused food offered to it, and showed marked signs of bad temper. These secondary symptoms were entirely absent in the case of the aldehyde free spirit. When the animal was sober it appeared perfectly normal, and if offered food took it apparently with relish.

These symptoms, which cannot fail to remind one of the so-called "Katzen-jammer" of the German student, are, oddly enough, most markedly relieved by precisely those substances which contain chemical groups capable of combining with and rendering innocuous these same aldehydes. The most general substance used in this connection is either ammonia itself or some compound containing amido (NH_2) groups. The action of all morning "pick-me-ups," from the student's red-herring to the viveur's effervescing citrate of caffeine, is apparently explainable upon this hypothesis, viz., that they neutralise the alhedyde constituents of the potable spirits.

THE ORIENTATION OF GREEK TEMPLES.

A PAPER, "Some Additional Notes on the Orientation of Greek Temples," an abstract of which was read before the Royal Society on February 14, gave an account of six Grecian temples of which the orientation had been examined or re-examined during the spring of 1900. The chief observations and results described in the paper may be stated as follows:—

(1) The grotto sacred to Apollo on Mt. Cynthus, in the isle of Delos, was interesting as being not improbably the very earliest existing structure of a religious character on Greek soil. The orientation seems, as usual, to have been connected with a zodiacal star, α Libræ, and the date of the formation of the grotto derived from this is about 1530 B.C. The original foundation of temples in Greece on some other sites are, indeed, more ancient than this; but it is presumed, and in a good many cases can be clearly established, that in those cases what can be now seen and measured is that which remains of reconstructions following the same lines as the earlier works. But this grotto at Delos, the sides of which are formed by the natural rock, and the roof and doorway only are artificial, is probably the very shrine alluded to by Virgil as already ancient at the time of the Trojan war (*Templa dei saxo venerabar structa vetusto*, Æn. iii. 84).

(2) At Delphi, where the clearance of the site by the French archæologists gave a better opportunity of examining the celebrated temple of Apollo, there is evidence of a change of orientation, one, evidently the more ancient, having the angle 231° 18′, the other 227° 8′. These are the angles of the axis when looking east, measured from the south point round by west. The site is very peculiar, being surrounded by mountains. The sun must have illuminated the sanctuary through an opening on the flank, as was the case at Bassæ, also dedicated to Apollo;

and there are only two dips between the mountains where the sunrise could have properly represented the early dawn. One of these has for amplitude $-7° 42'$ E., the other $-23° 16'$ E. The latter, taken with the earlier orientation, and the bright star ϵ Canis Majoris setting near the western axis, where the local horizon is favourable, suggests 950 B.C. as the date of the foundation. The sunrise at the $7° 42'$ point, and the sufficiently bright star β Lupi, setting also near the western axis of the more recent temple, offers the date of 580 B.C., but this would have been the predecessor of the structure which now occupies the site. It is known that the temple must have been several times rebuilt, and many stones of a previous temple, or temples, are found in the existing foundations.

At Syracuse it was found necessary to reconsider the orientation date (given in a former paper published in 1897) of the temple which has been attributed to Diana, but which is now known from an inscription to have been dedicated to Apollo. Of this temple, both the style of the architecture and the shape of the letters of the inscription above mentioned show that the date 450 B.C. given in the paper referred to, the orientation having been derived from the axis, is too late; and that the alternative date, derived from the northern limit of the eastern opening, which in this case can be obtained with accuracy, should be taken instead. The date, so altered, becomes 700 B.C., which is thirty-four years subsequent to the Hellenic foundation of the city.

N.B.—In Greek temples the question whether the sunrise entered upon the line of the axis or on the northern limit of the eastern opening has generally to be taken into consideration and decided upon archæological grounds. This results, in the majority of cases, in favour of the axis; but in an important minority—notably at Athens—the other has to be chosen.

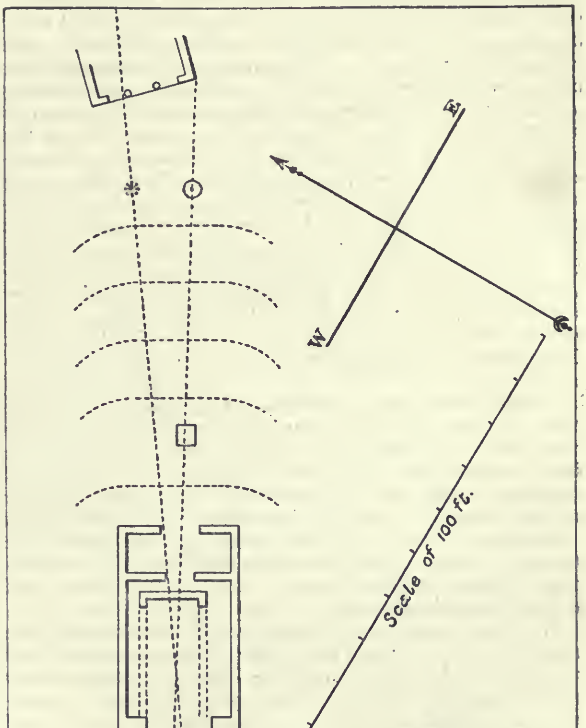
(3) In the paper an argument is drawn from the orientation of the foundations of a small temple lately discovered, adjoining the famous theatre at Taormina, that the theatre itself was that of the early and populous city of Naxos, which occupied the sea-coast at about 800 feet immediately below it; and not the work of the much later town of Taurominium, from which Taormina derives its name. Naxos was utterly destroyed by the Syracusans about 400 B.C.

(4) The most interesting example, however, is from another Sicilian temple lately unearthed at Selinus. Of this temple I found the orientation of the eastern axis to be $30° 22'$ north amplitude, which at once suggests a solar temple arranged for the summer solstice, which for a level site and for the date in question should be $30° 35'$. But the temple's site is near the bottom of a valley; and the sun would have to gain an altitude of rather more than two and a half degrees before it could shine into the temple, and then the amplitude required would be $28° 17'$. Thus, apart from what may be derived from the plan of the temple itself, the orientation theory would seem to show to a disadvantage.

The plan of the temple, however, appears to give the solution of the difficulty. It will be seen on examination of the accompanying figure that about 130 feet distant from the sanctuary there was a portico, *i.e.* the propylæa of entrance to the temple enclosure. One of two dotted straight lines drawn from this portico, namely, that which proceeds from its S.W. corner, indicates the direction of the first beam of sunrise as it rose at the summer solstice over the local horizon, about the middle of the sixth century B.C.; but it will be seen that whilst it passes centrally through the doorway it falls obliquely and excentrically upon the western internal wall of the temple, the amplitude of this line being $+28° 17'$ E.; but it will be also observed that it *does* fall centrally upon the western internal wall of a *naos* constructed within the flank walls of the temple. The square object which the line intersects before it reaches the temple is an altar, itself of no great height, and on lower ground, and which therefore interposed no obstruction to the solar rays reaching the sanctuary. The difference of level between the floor of the temple and that of the propylæa is about 18 feet. The warning star β Geminorum, which would have been heliacal—that is, just visible before extinction—about an hour before sunrise, and the direction of which is represented by the other straight dotted line, would have been well seen over the roof of the propylæa, the height of which, as known from architectural fragments, would not have exceeded 23 feet, and the star would have overtopped this by about 2°.

The explanation, by help of the plan, of the apparent misfit of the orientation is as follows:—

Presumably the angle upon which the lines of the



SELINUS

Newly discovered Temple

temple were set out was taken from data obtained on some platform which had a level horizon, and the building was considerably advanced before the actual solstice came round and showed the error that had been made.

To meet the difficulty, a *naos* was constructed within the flank walls, but hugging the northern one; so that the first beam of sunrise coming through the centre of the eastern aperture, at the local amplitude of $+28° 17'$ E., might shine in centrally upon the statue of the deity; and for this a pedestal was provided a little northwards of the centre of the niche which had been previously formed for it. We may notice also that the south-west angle of the propylæa is so placed as to keep exactly clear of the point of sunrise. F. C. PENROSE.

PILOT CHARTS.

FROM the popular and astrological point of view, meteorology is as old as the oldest of the canonical writings; but as a scientific study it may truly be said to belong wholly to the great Victorian era of scientific development. It was only in the 'thirties of last century that Redfield and Reid—the former in America, the latter in the West Indies—set about the patient study of the vagaries of storms, and discovered that these meteors were, like everything else in Nature, subject to natural laws. By the middle of the nineteenth century the progress made by the early pioneers was such that Maury felt justified in utilising the results in the preparation of his pilot charts for mariners all the world over. Maury's charts were certainly not perfect; fifty years afterwards many would, no doubt, regard them as a confused mass of information which would weary the most persistent student in an endeavour to unravel them; but useless as they seemed to be at first sight, they have proved to be the pioneers of the most useful works published in the interest of navigators. It has long been recognised that the sailor wants, in addition to ponderous tomes dealing minutely with every phase of navigation, handy summaries of the more essential features of everyday life on the ocean, arranged in a simple manner for immediate reference. The Board of Trade published charts containing varied information forty-five years ago, and the Hydrographic Department issued its well-known quarterly pilot charts more than thirty years ago. Other nations, France, Holland, Denmark, &c., have devoted much attention to the necessity of keeping mariners acquainted with all the latest information relating to the meteorology of the various oceans. For many years past the Hydrographic Department at Washington has left no stone unturned to popularise its Pilot Chart of the North Atlantic, and of late years it has been perfecting a similar work for the North Pacific. In the meantime, Germany has not only been increasing her naval strength, but her mercantile fleet is daily becoming more and more important, and the latest evidence of this is found in the January number of the *Annalen der Hydrographie und Maritimen Meteorologie*, in which Dr. Neumayer announces the issue, by the Deutsche Seewarte at Hamburg, of a monthly chart for the Atlantic, mainly for the steamships engaged in the Transatlantic trade.

But the importance of the question of keeping the mariner in touch with the progress of meteorology has not escaped the attention of the English authorities, for the Meteorological Council has just distributed a specimen monthly pilot chart of the North Atlantic and Mediterranean for the month of January, it having been decided to commence a series of such publications in April. In the compilation of the charts, advantage is to be taken not only of information in the possession of our own Hydrographic and Meteorological Offices, but also of any suitable facts published by similar establishments in other countries. Just as we are certain that the atmospheric conditions during winter are different in various ways from those which obtain in summer, so we may conclude that between the extremes there are, on the average, more or less gradual changes in the controlling features, and, therefore, we must expect that every month in the year has its own individualities, which are not exactly in agreement with even those of neighbouring months. To be of real use to the navigator, then, information should, as far as possible, be sorted out into its principal monthly features, and this is to be the aim of the Marine Department of the Meteorological Office under Commander Hepworth, R.N.R., the superintendent. Each ocean area of 5° of latitude by 5° of longitude contains a wind-rose showing the prevailing winds, some of the less frequent winds, and the frequency of calms, a simple method being adopted to indicate the mean strength of the wind, whether light, moderate, or gale. The normal limits of the Trades; the sailing routes recommended to and from the Equator; the steamship routes to and from America; the mean paths followed by cyclonic areas; the region in which gales exceed 10 per cent. of the wind observations; the localities affected by fog; and the ice limits about Newfoundland are laid down. A feature of as great interest to the theoretical physicist as to the practical sailor will be the ocean currents for each separate month, based upon observations covering a period of sixty-five years. Until the Admiralty and Meteorological Office recently published a selection of the currents in representative months, the scientific world had to be content with studying the circulation of the waters from a chart representing the annual results only. There will now be an opportunity for a much closer study, as the monthly winds and currents are given together in the same sea-room, while the distribution of atmospheric pressure for the same month is given, with that of the air and of the sea temperature, in an inset chart, and all three subjects must be considered as inseparable when investigating ocean currents. Two other inset charts represent south-westerly and westerly types of weather over Western Europe. In addition to the foregoing pictorial method of displaying the facts, a considerable amount of valuable information is conveyed in descriptive letterpress on all available spaces, directing the navigator's attention to the dangers associated with making the Spanish coast, to the Harmattan winds of West Africa, the Northers of the Gulf of Mexico, the Mediterranean sirocco and other winds; to treacherous inshore currents; to the difficulties arising from the low-lying haze and the great refraction along the west coast of Africa; to the rollers breaking on the South American coast, from Trinidad to Guiana; and advice is given as to the best routes for crossing the Equator. An interesting article is devoted to Atlantic storm systems, showing how the mariner must combine his wind and barometer observations when he wants to ascertain the behaviour of the disturbance which may be affecting his ship, the problem being much more complicated than is generally supposed, and more particularly in this age of swift steamships, which may be travelling faster than a cyclone, so that the experiences on a liner travelling eastward through a storm would be largely different from those on another meeting it going westward. Everything depends upon the particular circumstances, and with the aid of these notes and an intelligent interpretation of them, officers should be able to have a much better knowledge of the cyclonic areas through which they so frequently have to steer. For many reasons, the new pilot charts deserve to have a long and successful career.

MALARIA AND ITS PREVENTION.

SINCE the work of Laveran (1880) proved malaria to be a fever caused by the invasion of the blood by minute animal organisms, steady progress has been made in the work of probing and elucidating the etiology and pathology of this dreadful scourge.

The extent of its ravages was—and, unfortunately, still is—appalling, and the recognition of this fact has impelled many eminent scientific men to direct their best efforts towards solving the problems which have been facing us for the last twenty years, and which were the natural offspring of Laveran's discoveries.

English, Italian and German workers have competed with each other in the race and shown unprecedented keenness and enthusiasm; of their work an immense bibliography remains as a monument to-day. In America, too, has been done some of the very best work.

At the present time, however, though our knowledge of the Hæmamœbidæ has so much increased and though their pathological significance is now more clearly defined, yet we cannot say certainly that all the species which invade man have been identified.

In England we group all malaria parasites under three heads :—

(1) *Haemamoeba malariae*, the parasite of Quartan fever.

(2) *Haemamoeba vivax*, that of Tertian fever.

(3) *Haemamoeba precox*, that of Quotidian or æstivo-autumnal fever.

But in Italy Grassi states positively that he has observed a fourth species, which he names *Haemamoeba immaculata*. This species is without pigment and has been accepted by Marchiafava and Bignami, but our knowledge of the facts is still somewhat limited. In West Africa the first expedition which went out to investigate malaria was inclined to divide *H. vivax* into two distinct species differing in the colour of their pigment, one with fine brown and the other with fine black granules. Furthermore, it has been suggested that *H. precox* may be also split into two or more distinct species.

On these points we must await the results of patient investigations now pending.

For many years after the inseparable association of the Hæmamœbidæ with malaria had been demonstrated, the means whereby they could enter the blood and attack the corpuscles was unknown. But at last the work of Ross in India (with which Manson must ever be associated) enabled us to see light. King (1841) had suspected that mosquitoes were a factor in malarial infection, as also had Laveran ; but Ross led us, by his researches in the life-history of *H. relicta* (the parasite of birds), from mere hypothesis to fact. Confirmation was soon forthcoming in Italy, a country where the prevention of malaria is of great economic importance ; and later expeditions were dispatched by the Liverpool School of Tropical Medicine, the Royal Society and the German Government to various malarial districts, to thresh out the whole question and to evolve, if possible, some practical method or methods of prophylaxis.

Valuable experiments, too, were made in the Roman Campagna last year by the London School of Tropical Medicine, which afforded valuable confirmation of the views advanced by previous expeditions. More recently, too, an expedition from Liverpool has returned after making a complete survey of the lower reaches of the Niger, with the result that previous observations have been confirmed and further additions to our knowledge made.

Now we know, with a certainty rarely attained in medical matters, that malaria, instead of being inhaled with the night air as a noxious miasm from marshy countries or ingested with water, as was at one time suggested, is caused by the direct injection of animal parasites into the blood by mosquitoes previously infected by some human being suffering from the fever.

Careful microscopic work has shown that the Hæmamœbidæ of human malaria are parasitic not only in man but also in certain mosquitoes.

The parasites have two phases in their cycle of development, and need a different host for the completion of each phase, that is to say, that like many other well-known parasitic organisms, they exhibit "alternation of generation," in which man is the "intermediary" and mosquito the "definitive" host.

But it has been proved that all mosquitoes are not hospitable to the hæmamœbidæ of malaria. One genus only—Anopheles—has so far been convicted, though Culex has been subjected to an equally searching cross-examination.

Although Anopheles, as compared with Culex, is a small genus with a comparatively limited distribution, yet all its species have not been proved hospitable.

In West Africa *A. Costalis* and *A. funestus*, in British Central Africa *A. funestus*, in the West Indies *A. Costalis* (?), in Italy *A. Maculipennis*, are the species chiefly concerned as agents of transmission.

With the information at present obtainable it must, therefore, not be too hastily concluded that the whole genus Anopheles is hospitable to the parasites, but I venture to say that it may now fairly be assumed, on the other hand, that no species of Culex ever conveys the human parasites, though this genus is chiefly concerned as definitive host of the avian hæmamœbidæ.

White men who have travelled in the tropics say, assuming what you teach about the parasitic nature of malaria and the part played by mosquitoes to be the truth, there remains the question as to where the mosquitoes originally became infected. This was for a time a mystery, but the recent work of Koch in Java and Stephens and Christophers in West Africa has afforded an explanation. These observers independently discovered that though adult natives suffered little or nothing from malaria, yet their children from earliest infancy exhibited great numbers of parasites in their blood, though, like their parents, they rarely showed marked symptoms of infection. The blood of 80 to 90 per cent. of native children in some districts has been shown to contain parasites, and it has been noticed that these varied in number inversely as the number of years of life ; that is to say, evidence of parasitic invasion decreased as the children grew to manhood, and gradually a condition of partial immunity was attained.

Similar instances of acquired immunity are occasionally seen among white men who have lived many years in malarious countries. The mechanism of this immunity is as yet unknown.

It appears, therefore, certain that the prime source of mosquito infection is the native children, who, though not indifferent to mosquito bites, appear to view their ravages with equanimity. It follows, then, that the proximity of native habitations is a constant menace to the health of white men provided that the necessary connecting link—Anopheles—is also present. In considering the best means of prophylaxis, it will be seen that important deductions have been drawn from these facts.

The prime cause of malaria being known, its method of invasion having been satisfactorily demonstrated and the official seal of scientific approval to these facts having been obtained in Lord Lister's recent address to the Royal Society, it remains now to apply our knowledge in a practical way, so as to evolve some method or methods of prophylaxis and thereby crown a piece of scientific work as far reaching in its power to benefit the whole human race as any of those brilliant discoveries which have made the Victorian age conspicuous above all others.

And that this is not the language of exaggeration is readily seen when one considers the enormous tale of deaths caused annually throughout the world by malaria, and when one realises how much the control and development of new territory are arrested by the constant invalidism of Government officials, medical officers and traders in tropical climates, where it is constantly necessary to employ two men to do the work of one.

This latter point will appeal specially to those who recognise that the British Empire is now world-wide and tending to still further extend its borders.

During the last two years various authorities on paludism abroad, and members of the various expeditions from England, have made suggestions and recommendations as to the prophylactic measures which should be taken in consequence of the recent additions to our knowledge.

Some have advocated wholesale destruction of

mosquitoes by surface drainage and by the treatment of their breeding puddles with substances fatal to their development; others have suggested the careful and more extensive use of mosquito-proof curtains and blinds, &c.; while one distinguished authority holds that the continuous administration of quinine is likely to give the best results.

This apparent difference of opinion has afforded an opportunity for unbelievers to scoff; but there exists, notwithstanding differences of opinion as to detail, an entire unanimity as to the principles on which we should work.

With our present knowledge we are not justified in saying that any one alone of the measures mentioned above is of preeminent value, for all are not applicable to the same district, nor is the application of one method alone likely to prove sufficient.

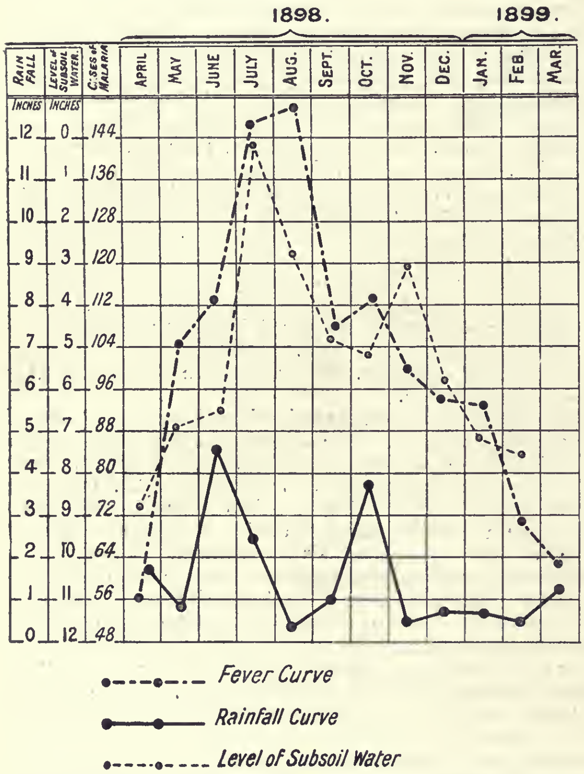


FIG. 1.—Chart showing relation of incidence of fever to rainfall and to level of subsoil water. (From figures supplied by Dr. Strachan, P.M.O. Lagos.)

It is in a due application of all these methods, in so far as each is practicable and suited to the district under consideration, that the truest salvation will be found.

In support of this view I would mention the conditions of rainfall and geological formation which obtain at Sierra Leone, Accra (Gold Coast) and Lagos (Fig. 1). In the first, surface drainage is possible and could not fail to somewhat reduce the ravages of malaria, but in the last-named colony any system of drainage is impossible; the town is built on a sandy island which has the general form of a saucer; here some other method must be considered. At Accra, on the other hand, the rainfall is so small and the soil so absorbent that there are no puddles or marshy lands which need draining. Here, again, some method other than drainage must be sought for.

Since the days of Empedocles of Agrigento (B.C. 500) the efficacy of surface drainage has been known and, where practicable, is doubtless one of the surest methods. But in districts unsuitable from any cause, the application of larvicidal substances (petroleum, tar, lime, &c.) has been suggested; but, so far as experiments go, the effect of such applications has proved too transient to be of much value. The essential point is to avoid being bitten by infected mosquitoes by night and also by day, for, notwithstanding statements to the contrary, I have repeatedly noticed Anopheles gorging themselves in full daylight, though no doubt their habits are chiefly nocturnal.

For this purpose the constant use of mosquito curtains of a proper kind is essential. Unfortunately, since familiarity breeds contempt, it is only too frequently that one finds in the tropics curtains of an utterly useless kind being used; either they are torn or the mesh is too large, or by their arrangement the free ingress of mosquitoes is possible.

They are best fixed on four posts at the four corners of the bed, and as the netting descends around the bed it should be tucked in under the mattress. The enclosed space should be of sufficient size to allow a certain freedom of movement during sleep, so that the danger of coming into contact with the netting is impossible.

More effectual, however, is the employment of wire gauze blinds to windows and doors, so that bedrooms and houses generally are kept entirely free from mosquitoes.

Celli recommends that windows should be protected by wire netting the meshes of which measure from 1 to 1·5 mm. square, and that all doors opening exteriorly should be protected by a cage of similar netting, so as to oppose two screens to the ingress of mosquitoes (see Fig. 2). He further suggests that to facilitate the capture of any stray mosquitoes all walls should be bare and painted white, and that trees should not be allowed to grow near dwellings, as they afford a retreat in which mosquitoes may hide. Experiments carried out in the Roman Campagna have proved that these and similar devices have been sufficient to protect from fever for considerable periods; but it is to be feared that unless unceasing vigilance be exercised all such precautions may prove ineffective, and one mistake may render them entirely abortive.

We need yet, however, further information as to the habits of mosquitoes. We do not yet know certainly how far they are able to travel, or at what height can they raise themselves from the earth. On these and many other points in the bionomics of Anopheles our information is very scanty. Giles' recent work on the Culicidæ has brought together practically all we know; but workers in many distant fields find that the habits of mosquitoes are liable to vary according as local conditions are suitable or the reverse; they are, it would seem, capable of a certain measure of adaptability to their environment.

All patients suffering from fever should be specially protected, for now we know that where malaria and Anopheles co-exist the fever is infectious; in consequence of the transmission power of the mosquitoes a fever patient is a source of danger to all his neighbours.

In the matter of clothing some precautions can be taken, such as the wearing of proper mosquito-proof boots and stockings. Mosquitoes are specially fond of the shades under a dining-table, where they may pursue their depredations unchecked.

The continuous use of quinine, though backed by such great names as Koch and Manson, is open to many objections, and is a method of prophylaxis unlikely, alone, to attain such great results as the former evidently expects.

Preeminent above all other methods of prevention stands *segregation*, advocated first by the first expedition to West Africa, and since supported so strongly by the researches of Koch and in the published work of the Royal Society Commission.

Native habitations have already been referred to as the source from which Anopheles obtains its parasites; native huts, ill-ventilated and overcrowded, are the hotbed in which the Hæmamœbidæ luxuriate.

In tropical countries Europeans pitch their temporary camps, and often live permanently, within a few yards of such native hovels; given, then, a full supply of Anopheles and a swarm of native children, 80 per cent. of whom are infected with Hæmamœbidæ, it is not surprising, with our present knowledge, that an epidemic of malaria soon starts among the white men.

The pitching of camps near native villages, or living in close proximity to native huts, is flying in the face of all recent scientific research, and suicidal in its results. This cannot be too often nor too emphatically reiterated.

R. FIELDING-OULD.

THE NEW STAR IN PERSEUS.

THE HARVARD OBSERVATIONS.

PROF. PICKERING, the Director of the Harvard College Observatory, in a *Circular* No. 56, has detailed the observations of the new star made there soon after its discovery by Dr. Anderson. This *Circular* we print *in extenso*:—

The cable message announcing the discovery of a new star in the constellation Perseus, by the Rev. T. D. Anderson, was received at the Observatory early in the evening of February 22, 1901. Owing to clouds, the new star was only occasionally visible, and twice it was necessary to cover the instruments on account of falling snow. During the intervals, however, various observations were made, which have a value owing to their early date. Numerous comparisons by Miss Cannon, with α Aurigæ, magnitude 0·21, α Orionis, magnitude 0·92, and α Tauri, magnitude 1·06, showed that the magnitude of the star was about 0·9. Photometric comparisons, by Prof. Wendell with the 15-inch telescope, of the Nova with the star +43°·732, magnitude 7·25, at 14h. 0m. and at 17h. 25m., Greenwich Mean Time, gave the magnitudes 0·35 and 0·39 respectively.

Meanwhile, an examination was being made, by Mrs. Fleming, of the photographs of the region obtained here earlier in the month, with the various instruments. Although photographs are taken with the transit photometer throughout every clear night, yet owing to twilight they cannot be taken as early in the evening as this star culminates. Fortunately, for some weeks the work of the transit photometer, which only photographs objects near the meridian, has been supplemented by photographs with Cooke and Ross-Zeiss Anastigmat lenses. With these instruments an attempt is made to cover the entire sky, both east and west of the meridian, at short intervals. The completeness with which this has been done is shown by the fact that we have photographs of the region of the Nova with the Cooke lens on February 8, 18 and 19, and with the Ross-Zeiss lens on February 2, 6, 18 and 19. The photograph taken with the Cooke lens on February 19 had an exposure of 66m., beginning at 11h. 18m. Greenwich Mean Time. While this photograph showed not only the faintest stars contained in the Durchmusterung, but also stars as faint as the eleventh magnitude, no trace of the Nova was seen. This result was confirmed by the other plates mentioned above. A general examination of the large number of earlier plates of this region did not seem to be necessary. Plates taken with the 8-inch Bache telescope as early as November 6, November 8 and December 12, 1887, fail to show the Nova, although the spectra of stars as faint as the eighth magnitude are clearly visible on all, and those of the ninth magnitude on the plate taken on November 6. A photograph taken with the 24-inch Bruce telescope on October 18, 1894, with an exposure of 15m., shows no trace of this object, although stars as faint as the magnitude 12·5 are well seen.

On this same evening, February 22, eighteen photographs were taken with various instruments, under the direction of Mr. Edward S. King. They showed that, photographically, the Nova was 0·3 fainter than α Aurigæ. The general appearance of the photographic spectrum resembled that of the Orion type and was very unlike that of other new stars, in which the bright lines are the most conspicuous feature. This star had a strong continuous spectrum traversed by thirty-three dark lines. The approximate wave-lengths, as derived by Hartmann's formula from the measures of Hε, Hγ and Hβ, are given below. Each is followed by its relative intensity, and by the difference found by subtracting it from the wave-length of the corresponding line, if any, in the spectrum of β Orionis. As the lines having greater wave-length than 5000 have thus been determined by extrapolation, they may be subject to large systematic errors.

3894, 10, Hζ, −5; 3970, 20, Hε, 0; 4026, 3, 0; 4077, 2, −1; 4102, 30, Hδ, 0; 4126, 5, +2; 4151, 1, −4; 4266, 2, +1; 4341, 40, Hγ, 0; 4366, 1, +1; 4388, 2, 0; 4415, 1; 4435, 1, +3; 4470, 2, +2; 4481, 20, 0; 4510, 2, −2; 4530, 2; 4552, 2; 4572, 1; 4616, 1; 4643, 1; 4665, 3; 4714, 3, −1; 4862, 40, Hβ, 0; 4885, 2; 4922, 2, 0; 5325, 1; 5399, 1; 5431, 1; 5677, 2; 5695, 7; 5719, 5; and 5761, 1. On careful examination the lines 3970, 4102, 4341, 4481 and 4862 were seen to be bright on the edge of greater wave-length. The line 4665 was bright on the edge of shorter wave-length, or there was a bright line whose approximate wave-length was 4660. The line 4026 was not measured, but identified from its position.

FIG. 2.—Hut with mosquito cage round door, which is itself mosquito proof (as suggested by Celli). Reproduced from a photograph lent by the Sanitary Institute.

On February 23 the clouds were so dense that few observations could be made. The star appeared to be brighter and bluer than α Aurigæ and to have the approximate magnitude 0·0. The spectrum was photographed faintly and showed no marked change except that the line K, which was absent on the previous evening, was present and nearly as intense as Hε.

On February 24 it became clear soon after noon, and at 1 o'clock the Nova was seen with the 6-inch Equatorial, and also with the 2-inch finder, in strong sunlight. In the evening the magnitude, according to visual comparisons, was 0·54, from measures with the 15-inch Equatorial, 0·59, and with the meridian photometer, in strong daylight, 0·28. Photographically it was 0·4 or 0·5 fainter than α Aurigæ. The spectrum showed a remarkable change. It was traversed by numerous bright and dark bands, and closely resembled that of Nova Aurigæ. The principal lines were dark with accompanying bright

lines of somewhat greater wave-length. The bright lines accompanying K and Hϵ were reversed, and traversed by narrow, well-defined dark lines. These last lines, and one of somewhat shorter wave-length than Hβ, are the only sharply defined lines in the spectrum, all of the others being broad and hazy, and difficult to measure with accuracy.

Clouds interfered with observations on February 25, but the Nova was evidently much fainter than on the previous evening. Its magnitude from visual comparisons was 1·4, from photometric measures, 1·07. The spectrum differed slightly from that on February 24. The lines Hδ, Hγ and Hβ were also reversed and replaced by one or more narrow dark lines.

On February 26 the magnitude from visual comparisons was 1·3, from photometric measures 1·49. The changes in the spectrum were slight.

Observations of the position of the Nova were made by Mr. J. A. Dunne, with the 8-inch meridian circle, on February 23, 24 and 25, with the result for 1900·0, R.A. 3h. 24m. 24s·02, Decl. + 43° 33′ 42″·4.

It therefore appears that on and before February 19, 1901, the star was invisible, or at least fainter than the eleventh magnitude. On February 21 its magnitude was 2·7, according to Mr. Anderson. On February 22 its magnitude was 0·5, perhaps becoming a little brighter on February 23, and then diminishing, so that on February 25 its magnitude was 1·1. Its spectrum on February 22 and 23 was of the Orion type, nearly continuous, traversed by narrow dark lines. During the next twenty-four hours an extraordinary change took place, so that on February 24 the spectrum resembled that of the other Novæ. It was traversed by bright and dark bands, and the principal dark lines had accompanying bright lines of slightly greater wave-length.

During the last fourteen years, and since the general application of photography to astronomy, eight new stars are known to have appeared—Nova Persei, in 1887; Nova Aurigæ, in 1891; Nova Normæ, in 1893; Nova Carinæ, in 1895; Nova Centauri, in 1895; Nova Sagittarii, in 1898; Nova Aquilæ, in 1899; and Nova Persei, in 1901. The second and last of these, which were much brighter than the others, were found visually by Dr. Anderson. All of the others were found by Mrs. Fleming, from an examination of the Draper Memorial Photographs. Nova Aquilæ was announced by telegraph, but has not been described in these circulars. Its position for 1900 is R.A. 19h. 15m.·3, Decl. − 0° 19′. It was not seen on plates taken on November 1, 1898, and earlier, although stars of the thirteenth magnitude appeared on some of them. On April 21, 1899, it was seventh magnitude. It appears on eighteen photographs taken during that summer, and on October 27, 1899, it was tenth magnitude. In July, 1900, when it was discovered, it was about twelfth magnitude. Seven bright lines—Hζ, Hϵ, Hδ, Hγ, 4693, Hβ and the nebular line 5007—were seen in the spectrum photographed on July 3, 1899. On September 7, 1899, Hγ and a somewhat fainter line, which is probably 4959, were the only bright lines visible. On October 27, 1899, Hγ and 5007 were alone visible and bright, so that the spectrum had then become that of a gaseous nebula.

EDWARD C. PICKERING.

NOTES.

AMONG other noteworthy remarks made by speakers at the jubilee dinner of the Royal School of Mines, on March 13, was one in which Sir George Kekewich, secretary of the Board of Education, acknowledged that science must occupy a place in any wise system of education. He said, "I should like to see the day when no education can be regarded as a liberal education which excludes a knowledge of science. In addition, I should like to see no one matriculating at any University in this kingdom who does not possess some knowledge of science. Indeed, I should like to see it recognised as part of the general education of every man who has any claims to possess a liberal education." The dinner was largely attended by past and present professors and students at the College. The chair was occupied by Sir George Gabriel Stokes, and toasts were proposed and acknowledged by the chairman, Sir Kenelm Digby, Prof. J. W. Judd, Sir William Roberts-Austen, Sir George Kekewich, Sir William Huggins, Prof. Le Neve Foster, Mr. Bennett Brough, Prof. W. A. Tilden, Prof. Milne, Mr. F. W. Rudler, Prof. Bauerman, Prof. J. Perry and Mr. Hugh McNeill, the secretary. The chairman described the gradual development of the School of Mines, and referred to the humble way in which it was established. "Even still," he remarked, "it bears indications of the tentative mode of proceeding to which I have already alluded, for Sir Norman Lockyer's elaborate work in astronomical spectroscopy, so far as taking observations on the heavenly bodies is concerned, is carried on in buildings of the nature of sheds." Sir William Roberts-Austen made mention of Stokes, Playfair, Hofmann, Huxley, Tyndall, Warington Smyth, and other brilliant men of science who had been connected with the College; and other speakers showed how professors and students have played important parts in various fields of scientific and industrial activity.

THE death is announced of M. Theodore Moutard, distinguished by his contributions to geometry.

M. A. NORMAND has been elected a correspondant of the Paris Academy of Sciences, in succession to the late General Alexis de Tillo.

THE ninth triennial conference of the German Meteorological Society will be held at Stuttgart on April 1, 2 and 3, the first half of Passion week, as Easter week, the usual time of the meeting, has been set apart for the Seismological Conference at Strassburg. Hail will form one of the principal subjects for discussion.

IT has been decided to hold the seventy-third meeting of the German Association of Naturalists and Physicians at Hamburg from September 22 to 28 next. In response to many representations there has been a rearrangement of the sections, which have hitherto numbered thirty-eight, but will in future be reduced to twenty-seven, and of these sixteen will be medical sections.

IT is reported that the grave of Hippocrates has just been discovered during excavations at Larissa, in Thessaly. A Royal Commission has been sent to the place by the Greek Government to take what measures may seem advisable.

THE *British Medical Journal* announces that Dr. C. W. Daniels has been appointed superintendent and medical tutor of the London School of Tropical Medicine, in succession to Dr. D. C. Rees. Dr. Daniels served on the Royal Society's Malaria Commission in 1898 for two years, and is now seconded for a further period whilst filling his present appointment at the London School of Tropical Medicine.

THE zoological lectures of the Zoological Society of London will be delivered in the Society's meeting room this year on Thursdays April 18, May 16, June 20 and July 18 at 4.30. The first lecture will be given by Prof. C. Stewart, F.R.S., conservator at the Royal College of Surgeons, and will relate to the various devices of nature for the protection and nourishment of young fishes. The lectures are free to Fellows of the Society.

THE latest number of the *Zeitschrift für wissenschaftliche Zoologie* (vol. lxix. part 2) contains three articles dealing with invertebrates. The first, by Herr J. Grofs, treats of the ovary of hemipterous insects; in the second, Herr C. Dawydoff treats of the process of regeneration among the brittle stars; while in the third, Herr O. Bütschli gives the results of his investigations into the nature of siliceous and calcareous sponge-spicules. In the latter it is shown that sponge-spicules, under the influence of heat, display minute cavities, which it is inferred exist under normal conditions, although too small to be detected. The

composition of both the organic and inorganic constituents of the calcareous spicules is worked out, the mineral matter being a double salt of $CaCO_3$ and K_2CO_3.

SERIOUS students of the science of meteorology will welcome Dr. J. Hann's "Lehrbuch der Meteorologie," the publication of which has just been commenced by the firm of Tauchnitz, Leipzig. The work will be completed in eight parts, and it is to be hoped that they will follow one another in quick succession. The first part contains a general introduction on the physics and chemistry of the atmosphere, and sections on radiation and daily and annual ranges of temperature. There are also charts showing the isotherms of the world in January, July, and of the year, and also representing the paths of hurricanes in the North Atlantic Ocean. The work will be reviewed when all the parts have been received.

WE have already referred on two or three occasions to the dispute between the authorities of Kew Observatory and the West London Tramways. The subject of the dispute—whether the currents leaking from the tramway rails would affect the readings of the magnetometers at Kew—was put to the test of experiment on Friday last, when the Board of Trade inspection of the electrical equipment of the Tramways was carried out by Mr. Trotter. For an hour or two the ordinary horse-car trams were replaced by electrically-driven cars, thirty of which were run on the line between Hammersmith and Kew. During this trial observations were made on the measuring instruments in the generating station by Mr. R. T. Glazebrook on behalf of Kew Observatory. It will be possible, by comparing the records thus obtained with the readings of the instruments at Kew during the time of the trial, to determine how far the leakage currents are likely to interfere with the value of the Kew records. Should an appreciable effect be observed, an arrangement will have to be made between Kew and the Tramways as to the amount of compensation to be paid by the latter for the cost of removing the instruments.

THE prospects of agricultural developments in South Africa were described by Prof. R. Wallace at a meeting of the Colonial Institute on March 12. After referring in detail to the crops produced in Cape Colony, the scanty herbage, the rearing of sheep and goats, the production of wool, ostrich-farming, the breeding of cattle, forest areas, and the products of Natal, he alluded to the Transvaal and the Orange River Colony. The south-eastern parts of the Transvaal, including New Scotland, he said, were specially suitable for sheep-breeding as well as for agriculture, the high central area for cattle and corn, the northern and lower elevations for coffee and sugar plantations and for tropical fruit culture. Good tobacco was largely grown in the Transvaal for export to other districts of South Africa. A great deal had been written about irrigation being the probable salvation of the country. Many small local ventures had been marvellously successful in transforming what was desert into gardens of Eden, and a good many promising irrigation schemes had been examined in various districts of Cape Colony, but most of them involved the expenditure of a large amount of capital and would require to be worked with much skill and care to make them pay. Without irrigation, the extent of South Africa that was capable of cultivation with satisfactory results was an infinitesimal fraction of the whole, and even that was subjected to periodical droughts which at times destroyed a whole season's crop; to destructive hailstorms, which were specially prevalent on the central plateau; and to fungoid parasitic pests on the common grain crops, which made the growth of European cereals practically impossible during the wet season of summer. It was highly probable that among the new disease-resisting breeds of cross-fertilised grains which had been produced at Newton-le-Willows by the brothers Garton, species of both oats and wheat might be found on experiment to overcome this difficulty; but still sufficient reasons remained why South Africa would never be a great agricultural country capable of exporting grain. With the development of the local irrigation schemes that were possible and better systems of management, it might more nearly produce the amount of food requisite for internal consumption.

THE *Newcastle Daily Journal* announces the death of Mr. Richard Howse, one of the old school of naturalists, who had been for half a century actively identified with the Natural History Society in Newcastle, and since the new museum was opened at Barras Bridge sixteen years ago he discharged the duties of curator. For a considerable period he acted as one of the secretaries to the Tyneside Naturalists' Field Club, and was also editor of its transactions. Mr. Howse was one of the first geologists to study the Permian rocks of the north-east coast, and he made a number of important observations of the carboniferous fossils of the north of England, many interesting specimens of which have been named after him. He was a prolific writer, and in addition to many papers which were published in the transactions of the local societies, he prepared an interesting "Guide to the Natural History Museum." He compiled other volumes dealing with the exhibits in the Barras Bridge Museum, amongst the number being a "Guide to the Collections of Local Fossils," and a "Catalogue of the Fishes of the Rivers and Coast of Northumberland and Durham." Prior to this publication, no systematic list of the fishes found on the coast and in the rivers of Northumberland and Durham had been issued. Mr. Howse also published an index catalogue of birds in the Hancock collection and a catalogue of Permian fossils, and was joint editor with Mr. J. W. Kirby of a "Synopsis of Geology of Northumberland and Durham."

A METHOD of distinguishing human blood from that of animals has been discovered independently by Dr. Uhlen-Luth, of Greifswald, and Drs. Wassermann and Schutze, of Berlin, and is described in the *Medical Press and Circular* of March 13. From this account of the investigations it appears that it is now possible to obtain a definite reaction from blood-stains, however old, which indicates with something approximating absolute certainty the source of the blood under examination. This result is based on the fact that the blood serum of animals which have been injected with the blood of an animal of a different species, when added to a dilution of blood from the latter, produces therein a well-marked precipitate. Thus, if a rabbit be injected with human blood, the serum of the rabbit blood, when added to a dilution of human blood, causes immediate turbidity, a phenomenon which is conspicuous by its absence when it is added to dilutions of any other kind of blood. The only element of uncertainty is that the blood of monkeys reacts, to some extent, in the same way as human blood; but apart from the fact that the medico legist is seldom likely to be called upon to differentiate between these two varieties, there is a notable difference in the length of time required for a dilution of monkey's blood to become cloudy as compared with that of man. Full details of the procedure will be found in our contemporary.

THE Meteorological Council have just published a series of charts illustrating the weather of the North Atlantic Ocean in the winter 1898–9. This period was marked by a succession of severe gales, and it will be remembered that public interest was especially aroused by the anxiety as the safety of the liners *Pavonia* and *Bulgaria*. The charts illustrate the state of the weather from December 18, 1898, to February 15, 1899, com piled from observations from the log-books of some 200 vessels,

and show that during the month of January and the first half of February the weather was exceedingly boisterous, and the period was also noteworthy by the great difference of temperature between the eastern and western shores of the Atlantic. For instance, between Fort Logan, in Montana (latitude 47° N.), with its terribly severe frost of − 61° in the night of February 10, and Liège in Belgium (latitude 48° N.), with its temperature of 70°·5 on the afternoon of the 10th, there was a difference of 131°·5, while over extensive regions of America and western Europe there was a difference of more than 100°. This combination of circumstances seemed to indicate the occurrence of some peculiar atmospheric conditions of which the Meteorological Council considered a permanent record was desirable.

THE *Proceedings* of the American Academy of Arts and Sciences for January contain a description of an ingenious apparatus devised by Mr. F. A. Laws for recording alternating current waves. The system is a modification of the "point-to-point" or "contact" method; by a mechanical arrangement which automatically shifts the position of the contact brushes, the galvanometer deflection instead of being changed intermittently is made to alter gradually, thus slowly following the wave-form. The reflected spot of light is received on a moving photographic plate on which it imprints a record of the wave-form. The method only gives the average wave-form, but inasmuch as this is obtained in a few minutes, it is a considerable improvement on the older "point-to-point" systems. But now that oscillographs have been developed into thoroughly practical instruments by Blondel, Duddell and others, the "point-to-point" method must be regarded, we think, as having had its day.

SOME experiments on the heat evolved when powders are wetted are described by Signor Manfredo Bellati in a recent pamphlet (printed by Carlo Ferrari, of Venice, 1900). It has been suggested as an explanation of the phenomena that the heating is due to the compression produced in the stratum of liquid immediately surrounding the solid, and this explanation has been confirmed by the experiments of Jungk, according to which, when the water is below 4° C., cooling, instead of heating, takes place, such as would occur in water below the temperature of maximum density when subjected to an increase of pressure. This result has been negatived by the experiments of Meissner. The present writer points out, however, that since the effect of pressure is to lower the point of maximum density, it does not necessarily follow that cooling must always occur at temperatures below 4° C., and hence the above hypothesis is not necessarily inconsistent with Meissner's results. In Signor Bellati's experiments dry sand was found to become heated when wetted with water even at a temperature of 0° C. When the sand had been previously moistened, however, the author found that at 0° C. heating occurred when the sand contained more than 2·1 or less than 1·4 per cent. of water, but that with percentages between these limits cooling sometimes took place instead. The author describes some further experiments conducted with the object of testing Canton's and Martini's theory.

IN addition to other communications, the second part of the Bergens Museum *Aarbog* contains two papers, one by Mr. O. Nordgaard and the second by Mr. E. Jorgensen, dealing with the "plankton" of the North Sea, as well as one by Emily Arnesen, treating of the sponges of the Norwegian coasts. In the *fjords* of western Norway it is ascertained that the deep plankton fauna is of an Arctic character; copepods existing in the deep layers, where Atlantic conditions prevail, which attain their maximum development, both as regards size and number, in the Arctic Ocean. We have likewise received the *Aarsberetning* of the Bergen Museum, in which we notice an excellent reproduction of a photograph of a portion of the zoological gallery.

THE first fasciculus of an important work on the Hydroids, or Hydromedusæ, of the North American seas, now in course of publication by the Smithsonian Institution as *Special Bulletin* No. 4, has been received. The rich material for the history of this group of zoophytes accumulated in the U.S. National Museum, as one of the results obtained by numerous dredging expeditions of late years, has never hitherto been worked out, and the detailed investigation now being undertaken promises very important additions to our knowledge of the group. The present fasciculus, by Prof. C. C. Nutting, of Iowa University, deals with the Plumulariidæ, of which it is doubtful if more than fifty North American species were previously known. The result of the investigation is to show that, in place of Australia, the West Indian area is the richest in plumularian life of any region of the equal size in the world.

WE have received the *Sitzungsberichte* of the Royal Bohemian Society for 1900, which forms a thick volume containing, among other matter, nine articles on zoological and the same number on botanical subjects. Of the former perhaps the most interesting is one by Dr. A. Mrázek, describing the discovery of a small freshwater nemertine worm in a tank in one of the hothouses in the Botanical Garden at Prague. So little is at present known of the freshwater representatives of this group that every new fact is of importance; but since specimens have been found in regions so far apart as Nicaragua and Turkestan, there can be little doubt that some forms are indigenous to freshwater. The specimen described by Dr. Mrázek is identical with *Stichostoma* or *Tetrastemma*, *graecense*, of which the other known example was taken in a warm-water tank in the Botanical Garden at Gratz; the species is, therefore, probably introduced. The author adds some general remarks with regard to freshwater faunas.

THE issue of the *Revue Scientifique* (*Revue Rose*) of March 9 contains a long and interesting article by M. Louis-Adrien Levat on the destruction of birds, especially by means of traps and snares, which he declares to be illicit. After a brief survey of the persecution to which birds were exposed in ancient times, and reference to the fact that taking the hen sitting on her nest is expressly forbidden by the Mosaic code, the author goes on to say that during a single spring a few years ago no less than 1500 nests were taken in one French province. This represents a prospective loss of about 6000 birds, which might be expected to consume some 6,000,000 insects among them. He adds the significant observation that in the year 1860 one hundred cages filled with insectivorous birds of various kinds were exported from Baden to New South Wales; and that at the present day it would be almost impossible to send such another cargo, owing to the scarcity of these birds on the continent. And it is not alone the disappearance of bird-life and bird-song from the country districts that is to be deplored. The effects on agriculture, horticulture and the grape industry are simply disastrous. Some birds, it is computed, will consume 200,000 insects per season, and others as many as 600 per day. A single insect-eating species may be the means of saving 3200 grains of wheat and 1150 grapes daily! In Hérault alone the destruction of insectivorous birds is calculated to cost the department 100,000 hectolitres of wine annually. And in some districts of France the country is practically desolated by insect ravages owing to bird-slaughter. From the fact that in France so-called sportsmen are in the habit of shooting small birds, the situation is much worse than in England. Remedial measures are urgently needed, but the author says he is preaching to deaf ears.

THE Trinidad *Bulletin of Miscellaneous Information* states that a recent analysis made by Prof. Carmody, Government Analyst, confirms the previous work of Francis as to the presence of prussic acid in sweet cassava, the proportion found

varying from 0·005 to 0·019 per cent. The skin was found to yield from 0·014 to 0·042 per cent., while the inner part gave only 0·003 to 0·015 per cent. The interior part of bitter cassava yielded 0·013 to 0·037 per cent., while the skin and outer layer yielded from 0·012 to 0·035 per cent. Peeling sweet cassava before cooking is therefore a wise precaution. Prof. Carmody also suggests that the acid may in part be formed by fermentative change.

MR. C. THOM (*Trans.* Acad. Sci. St. Louis, ix. No. 8) gives an account of the details of fertilisation as observed in ferns belonging to the genera Aspidium and Adiantum. In describing the development of the spermatozoa he states that a blepharoplast is present in the cytoplasmic part, and that the nuclear portion really consists of a hollow tube, chiefly composed of chromatin, enclosing a core of a substance probably representing a transformation of nucleolar matter. When the sperm reaches the archegonium, the cytoplasmic envelope becomes more or less functionless, and the nuclear part wriggles to the egg by an autonomous movement. The cytoplasmic portion containing the blepharoplast either is thrown off before the egg is entered or it is detached and disintegrates in the egg cytoplasm. Hence the importance which has been ascribed to this body, as the result of a comparison with animal centrosomes would seem to have been exaggerated. The coiled nuclear part of the sperm enters the nucleus of the egg, in which it can be recognised for some time. Ultimately, however, the mixing of the egg and sperm nuclear constituents becomes so complete that finally no difference between the sexual elements can be detected.

THE report of the work of the Division of Forestry of the U.S. Department of Agriculture during the year 1900 has been issued. The year witnessed a conspicuously wider and more effective and intelligent interest in forest matters in the United States than any previous year. To give an idea of the extent of the work it may be mentioned that during the year applications were received for working plans for 48,078,449 acres, personal examinations on the ground were made of 2,103,670 acres, working plans were begun upon 1,325,000 acres; plans were completed for 179,000 acres, and 54,000 acres were put under management. In accordance with the request of the Secretary of the Interior, the preparation of a working plan for the Black Hills Forest Reserve was begun as the first step toward conservative lumbering on the national forest reserves. A unique and most promising study of the effect of forest cover on the flow of streams has been commenced in southern California upon the lands of the Arrowhead Reservoir Company, whose observations of precipitation, run-off, evaporation and temperature for eight years have been placed at the disposal of the Division of Forestry. A careful study of the subordinate watersheds, which differ completely among themselves in the character of their forest covering, has been undertaken, and strong hopes are entertained of valuable results from the comparison of the run-off from various types of cover. An investigation of the value of the widespread views regarding the effect of denudation upon the once forested lands bordering the Mediterranean Sea has been begun, and the conditions in Tunis, Algeria and Tripoli have been studied.

WE have received a reprint from the Twelfth Annual Report of the Missouri Botanic Garden, a monograph of the Crotons of the United States, by Mr. A. M. Ferguson. It includes about twenty-four species, and is illustrated by thirty-one plates.

A DAINTY and cheap edition—the price is only eighteenpence net—of Izaak Walton's "Complete Angler," has been published by Messrs. Gay and Bird. This matchless idyl of angling and its associations, first appeared in 1653, and the present volume is a reprint of the text of the fifth edition (1676), as revised by Sir John Hawkins. The book is just the kind of volume to slip into the coat pocket, to be read at quiet moments by contemplative naturalists, whether anglers or ramblers, who find pleasure in observing nature.

SEVERAL interesting articles upon scientific subjects appear in the March magazines which have come under our notice. The *Idler* contains an instructive description of the Jena glass works and of Prof. Abbe's researches. Mr. Walter Wellman describes some experiences of his Polar expedition of 1898–1899. A fine series of instantaneous photographs showing the forms assumed by water thrown out of a bucket is reproduced in *Pearson's Magazine*. Dr. Louis Robinson describes popularly how adaptation to environment may lead to the survival of such animals as the giraffe, camel and zebra; and a description is given of a trip in an immersible boat, the *Argonaut*. In *Scribner's Magazine* some of the geographical discoveries made between 1825 and 1900 are shown by comparative maps. *Good Words* contains articles on Mr. Edison, insect pests, and the building of the locomotive.

THE current number of the *Berichte* contains a paper by W. Ipatieff upon the action of a high temperature upon alcohols. Since the researches of Berthelot upon the substances produced when various substances are passed through red-hot tubes, very little work has been done in this direction. It is now found that in the case of alcohols the reaction is a much simpler one than would be expected, the corresponding aldehyde being the chief product. In many cases the yields are so good that it forms an advantageous method for the preparation of certain aldehydes. The hot tube may be of glass or iron, preferably the latter, the temperature giving the best yields being about 700°. Methyl alcohol treated in this way gave 25 per cent. of the theoretical quantity of formaldehyde, isobutyl alcohol about 40 per cent. and isoamyl alcohol 30 to 40 per cent. of the corresponding aldehydes.

OWING to the fact that the values obtained for the atomic weights of iodine and tellurium are inconsistent with their relative positions in Mendeléeff's table, numerous determinations of the atomic weight of the latter element have been made in recent years, the results obtained varying between 127·5 (Staudenmayer) and 128 (Wills), all being above that of iodine (126·8) instead of below it as required by the periodic law. As is pointed out, however, by Herr O. Steiner in the current number of the *Berichte*, all these determinations of the atomic weight of tellurium are based upon the analysis of inorganic preparations, the methods of purification adopted giving no complete guarantee that small quantities of substances of similar properties but different atomic weights may not be present. The fact that tellurium forms a stable and well-defined diphenyltelluride, $Te(C_6H_5)_2$, distilling without decomposition in a vacuum, was therefore utilised for a fresh determination. Although these preliminary results have not the high degree of precision necessary for the complete resolution of the problem, Herr Steiner points out that the accuracy obtainable by an ordinary combustion is sufficient to fix the atomic weight of tellurium to within 0·5, and several results obtained by combustion of the carefully fractionated product gave a mean value of 126·4, a figure much lower than those mentioned above and agreeing with the prediction of the periodic table. As a confirmation of the method, a similar set of experiments upon diphenylselenide gave the values 78·8 and 79·3, the number usually adopted being 79·1. The results of more exact determinations carried out upon material purified by this method will be awaited with interest.

THE additions to the Zoological Society's Gardens during the past week include a Dingo (*Canis dingo*) from Australia,

presented by Mr. W. R. Temple; a Pinche Monkey (*Midas aedipus*) from Colombia, presented by Lady Moor; a West African Python (*Python sebae-natalensis*) from Natal, presented by Mr. Alex. Buchanan; a Spotted Ichneumon (*Herpestes auropunctatus*), four Hamilton's Terrapins (*Damonia hamiltoni*), seven Bungoma River Turtles (*Emyda granosa*), eight Roofed Terrapins (*Kachuga tectum*) from India, a Common Boa (*Boa constrictor*) from South America, deposited; a Maguari Stork (*Dissura maguari*) from South America, four Gouldian Grass Finches (*Poëphila gouldiae*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

Nova Persei.— Prof. H. C. Vogel describes, in the *Astronomische Nachrichten* (Bd. 154, No. 3693), the results of measures of photographs of the spectrum of Nova Persei, taken with the 80 cm. refractor and spectrograph of small dispersion. The spectra extend from λ 3740 to λ 5800. Wave-lengths have been determined by comparisons with the spectrum of β Orionis (Rigel). Tables of the wave-lengths of the deduced lines are given, the origins being traced to hydrogen, calcium, magnesium and silicon. The displacements of the lines is shown to indicate a velocity of some 700 kilometres per second relative to the earth; an exception to this occurs in the case of the two calcium lines at H and K, which are indicated as giving velocities of approach of only 45 kilometres per second.

Variability of Eros.—At the Lyons Observatory MM. Guillaume, Le Cadet and Luizet have recently obtained a series of estimations of the variations in the brightness of Eros, observing with an equatorial coudé of 0·32 metre aperture and a Brunner equatorial, 0·16 metre aperture. A diagram of the light curve is given. This is similar to that of β Lyræ, but the secondary minimum is almost equal to the principal one. The determinations gave

		h. m.
Principal minimum to secondary minimum	=	2 51
Secondary ,, principal ,,	=	2 24
Principal maximum to secondary maximum	=	2 50

Details of estimates on seven nights during February are given (*Comptes rendus*, cxxxii. pp. 530-531).

In the same issue M. Luizet gives the elements for computing future minima as follows:—

$$1901 \text{ Feb. } 20. \ldots \left.\begin{matrix} 7^{h}\,57^{m} \\ 10\;48 \end{matrix}\right\} + 5^{h}\,16^{m}{\cdot}15\ \text{E.}$$
$$\phantom{1901 \text{ Feb. }} 20. \ldots$$

The eccentricity of the orbit of the system would thus be about 0·0569, which is nearly equal to that of the moon's orbit (0·0549).

In the current issue of the *Comptes rendus*, M. L. Montangerand describes the photographic investigations which have been made with the astrographic refractor at the Toulouse Observatory. It is interesting to note that the measures so obtained agree very well with visual determinations. The planet was allowed to trail over the plate, and the points of equal brightness marked off at intervals. The period thus found is given as 2h. 38m. (2h. ·63) (*Comptes rendus*, cxxxii. pp. 616–618).

In close agreement with this result is the determination of Prof. Deichmüller at Bonn, who gives 2h. ·61 as the period of variation. This observer gives also, for the two evenings of February 21 and 22, a series of estimations of magnitude at intervals of ten minutes from 5·0 to 10·0 p.m. (*Astronomische Nachrichten*, Bd. 154, No. 3693).

New Variable, 2 1901 (Cygni).—Dr. T. D. Anderson announces, in the *Astronomische Nachrichten* (Bd. 154, No. 3692), the discovery of a new variable star. Its position is

$$\left.\begin{matrix} \text{R.A.} = & 19^{h}\; 12^{m}{\cdot}2 \\ \text{Decl.} = & +\,49^{\circ}\; 55' \end{matrix}\right\}(1855{\cdot}0).$$

And the variations recorded are

1900	Dec. 26	...	9·5
1901	Jan. 12	...	9·8
	Feb. 16	...	10·4

Observations of Circumpolar Variable Stars.—Vol. xxxvii. part 1 of the *Annals* of the Harvard College Observatory contains the results and discussion of the observations of 17 circumpolar variables made at the institution during the period 1889–1899. The estimates of magnitude were made by Argelander's method, but differ from similar observations of other workers in two respects—first, the stars have been observed throughout the whole period of their variation of light; and second, all the observations have been reduced to a uniform photometric scale, that of the meridian photometer. This latter peculiarity is of great importance, as by its means the stars can not only be systematically compared *inter se*, but collateral comparisons made with stars of constant brightness in any part of the sky. Both the 15 inch and 6-inch equatorials have been employed in the work.

Three of the stars, T Persei, S Persei and R Ursæ Minoris appear to be irregularly variable. With the exception of these, mean light curves have been deduced for the variables, and tables are given showing the phases obtained by this means. An examination of the curves shows that the principal maximum is in several cases preceded, and in a few cases followed, by a more or less marked *secondary* maximum.

Treating these variables as a class, it is noted that the

mean of all the periods ...	=	363·4 days
mean magnitude at maximum	=	7·81
,, ,, ,, minimum	=	12·64
So that the range is therefore	=	4·83 magnitudes.

Drawings are given of the mean light curves of 14 of the variables, and 16 small charts showing their positions with respect to the surrounding stars.

EROS AND THE SOLAR PARALLAX.

Few projects involving long continued observation and laborious calculations have received a more ready assent or commanded a wider co-operation than that which has for its aim the determination of the solar parallax from observations of the planet Eros. This readiness to adopt a general programme was materially assisted by the meeting of the International Astrophotographic Congress at Paris, in July 1900, whereby the directors of many of the best equipped observatories were able to rapidly mature their plans and to complete the necessary organisation. The representatives of some twenty observatories gave in their adhesion to the proposal, which contemplates the collection of measures, either photographic, micrometrical or heliometric, and the necessary meridian observation of a large number of comparison stars. The general scheme follows the well-known lines of utilising observations made at considerable hour angles east and west of the meridian at any one observatory, of combining the observations made in the north and south hemispheres, and adds the somewhat novel feature of making available simultaneous observations of the planet at stations in America and Europe, a suggestion which, among other advantages, has the effect of eliminating errors arising from an imperfect knowledge of the planet's motion.

Under date, Paris, January 31, M. Loewy gives an interim report of the progress of the observations up to the end of the year 1900. M. Loewy and those responsible for the inception of the scheme are to be congratulated on the energy exhibited and the hopeful results obtained. The report states that, notwithstanding the bad weather that has generally prevailed in the northern regions of our hemisphere, not one day has passed in which the planet has not been observed by one or other of the several methods adopted. The number of coincidences of observation between the three contributing American observatories and those in Europe is shown by the following figures:—

Number of Coincidences up to December 31, 1900.

	Madison.	Washington.	Williams Bay (Yerkes).	Total.
Micrometric ...	40 ...	49 ...	106 ...	195
Photographic ...	15 ...	30 ...	66 ...	111

The English observatories of Oxford and Cambridge (Greenwich is not reported) are in the least favourable position, since the arc of the Great Circle intercepted between them and the average American station is only about 55°; but seeing that the parallax of the sun can be determined quite independently of the motion of the planet, and that the stars of comparison will be the same in the two cases, a very small error can be anticipated under the least favourable conditions. Considerable attention has been given to the amount of this error, and one

can only hope that the favourable presage will be realised. The probable limit of error is based upon a preliminary inquiry due to M. Hermann Struve, of Königsberg, who has found that the probable error of a single complete micrometrical measurement is $\pm 0''.077$, and such an error would introduce no greater uncertainty into the parallax than $0''.03$, a most satisfactory result for one night's determination. Such a favourable result, however, implies (1) that we are in possession of the accurate diurnal motion of the planet; (2) that no error exists in the relative position of the stars of comparison, and (3) that every source of systematic error has been eliminated. It is not unimportant to observe in this connection that the motion of the planet itself in one second of time can amount to, and even exceed, $0''.03$ in the arc of a great circle, no inconsiderable fraction of the total error found by M. Struve. The actual epoch of exposure, with a rapidly moving shutter, would probably be known to much less than a second of time, but the proper moment to assign to the formation of the image seems to be open to more doubt. A question of very similar import has been discussed at Paris by M. Henry, and has been reported upon. This has reference to the formation of the trace of the planet on the sensitised film, when the equatorial is driven to sidereal time by means of a star. M. Henry photographed a region of the sky with an exposure of three minutes, in which an acceleration and retardation of three seconds was alternately given to the driving clock. Two other exposures were made on the same plate in the reversed order, and the differences of right ascension of the centres of the traces were measured. The mean of the differences of the measured distance with clock accelerating was compared with the mean of the distances clock retarding, in groups according to magnitude, with the following result:—

Number of stars.	Mean magnitude.	Mean diff. of distance.	Prob. error of the mean.	Prob. error of a distance.
		$''$	$''$	$''$
13	9·3	+0·10	±0·02	±0·06
20	11·3	−0·03	±0·02	±0·09
25	12+	−0·02	±0·03	±0·13

The large probable error in the third group is quite sufficiently explained by the faintness of the stars and the shortness of the exposure, but we seem to be in presence of errors of quite the same order of magnitude as those found by M. Struve. Certainly one of the most interesting of the results that will proceed from this elaborate programme will be the relative certainty and freedom from systematic errors of the various methods of observing.

This memoir or report also contains, besides an ephemeris of the planet supplied by M. Millosevich and a table of star constants applicable to the stars used in the discussion of the photographic plates, a memoir by Mr. Comstock on the computation of refraction in the direction of the diurnal motion of the planet. Other points which have been discussed are crowded out of the present number, but enough is given to assure us that the International Committee forms a centre of activity calculated to attract the energy and the enterprise of all the cooperating astronomers. But it is impossible to anticipate, as the result of so much labour, anything more than an academic interest. Based upon the constants employed in the reduction and an assumed figure of the earth, the resulting parallax will represent the best value procurable from an isolated inquiry; but in view of the solemn acceptance of the value $8''.80$ for the solar parallax at the Paris Congress in 1896, it seems extremely improbable that the various national ephemerides will make any alteration in a value which has been so recently introduced.

FORTHCOMING BOOKS OF SCIENCE.

Mr. Edward Arnold announces:—"The Physiological Action of Drugs, an Introduction to Practical Pharmacology," by Dr. M. S. Pembrey and Dr. C. D. F. Phillips; "The Morphology of the Brain: an Introduction to the Study of the Comparative Anatomy of the Brain in the Vertebrata," by G. Elliott Smith; "A Text-book of Biology," by G. P. Mudge; "Applied Embryology and Morphology," by Dr. A. Keith; "Anthropology and its Practical Value," by E. W. Brabrook; "A School Botany: being an Introductory Text-book on the Study of Flowering Plants," by David Houston, illustrated; "Wood: a Manual of the Natural History and Industrial Applications of the Timbers of Commerce," by Prof. G. S. Boulger; "A Handbook on Fermentation and the Fermentation Industries," by Charles G. Matthews; "The Dressing of Minerals," by Prof. Henry Louis; "Traverse Tables for Surveyors and Engineers," by Prof. Henry Louis and G. W. Caunt; "Physical Calculus," by Rev. P. E. Bateman.

The announcements of Messrs. Baillière, Tindall and Cox include:—"Cerebral Science: Studies in Comparative Psychology," by Dr. Wallace Wood, illustrated; "Gold and Diamonds: South African Facts and Inferences," with coloured maps and thirteen plates, by W. H. Penning; "Suggested Standards of Purity for Foods and Drugs," by C. G. Moor, Cecil H. Cribb, and Martin Priest.

Mr. B. T. Batsford promises:—"Sanitary Engineering," by Colonel E. C. S. Moore, illustrated; and a new edition of "New Tables for the Complete Solution of Ganguillet and Kutter's Formula," by Colonel E. C. S. Moore.

Messrs. A. and C. Black will publish:—"Encyclopædia Biblica," edited by Rev. Prof. Cheyne and Dr. J. Sutherland Black, vol. iii.; "Geography of South America," by L. W. Lyde; "World Pictures and Problems, an Elementary Pictorial Geography," by Joan B. Reynolds, illustrated; "New Descriptive Geography of Africa," edited by Dr. A. J. Herbertson and F. D. Herbertson; "Introduction to the Study of Physics," by A. F. Walden and J. J. Manley, vol. i., General Physical Measurements, illustrated; "A Treatise on Elementary Statics," by W. J. Dobbs.

The announcements of the Cambridge University Press include:—"Scientific Papers," by John William Strutt, Baron Rayleigh, F.R.S., vol. iii.; "Papers on Mechanical and Physical Subjects," by Prof. Osborne Reynolds, F.R.S., reprinted from various transactions and journals, vol. ii.; "Scientific Papers," by the late Dr. John Hopkinson, F.R.S., in 2 vols.; "A Treatise on Determinants," by R. F. Scott, a new edition by G. B. Mathews, F.R.S.; "A Treatise on Spherical Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere, Collected during the Years 1895, 1896 and 1897," by Dr. Arthur Willey. Part v. An account of the Entozoa, by A. E. Shipley, with 3 plates; of the Nemertina, by R. C. Punnett, with 5 plates; the development of the Robber Crab (*Birgus*), by L. A. Borradaile, with 8 figures in the text; new genera and species of Entomostraca, by the Rev. T. R. R. Stebbing, F.R.S., with 5 or 6 plates; anatomy of *Neohelia porcellana* (Moseley), by Edith M. Pratt, with 2 plates. The entire work will be completed with the publication of part vi., which will be issued during 1901, and will contain Dr. Willey's monograph on *Nautilus* and other articles, including an account of the Ascidians, by Prof. W. A. Herdman, F.R.S.; "Reports of the Anthropological Expedition to Torres Straits by the Members of the Expedition," edited by Prof. A. C. Haddon, F.R.S., vol. ii., Physiology and Psychology; "Fauna Hawaiiensis, or the Zoology of the Sandwich Islands," being results of the explorations instituted by the Joint Committee appointed by the Royal Society of London for Promoting Natural Knowledge and the British Association for the Advancement of Science, and carried on with the assistance of those bodies and of the trustees of the Bernice Pauahi Bishop Museum, edited by Dr. David Sharp, F.R.S., Secretary of the Committee; "Zoology," by Prof. E. W. MacBride and A. E. Shipley; "Lectures on Great Physiologists," by Prof. Sir Michael Foster, Sec. R.S.; "Fossil Plants, a Manual for Students of Botany and Geology," by A. C. Seward, F.R.S., vol. ii.; "The Soluble Ferments and Fermentation," by Prof. J. Reynolds Green, F.R.S., new edition; "British Grasses," by Prof. H. Marshall Ward, F.R.S.; "Electricity and Magnetism," by R. T. Glazebrook, F.R.S.; "The Teacher's Manual of School Hygiene," by Dr. E. W. Hope and Edgar Browne; "An Introduction to Logic," by W. E. Johnson; "Euclid, Books I.-III., with Simple Exercises," by R. T. Wright; "An Introduction to Physiography," by W. N. Shaw, F.R.S.; "A Brief History of Geographical Discovery since 1400," by Dr. F. H. H. Guillemard; "A New Primer of Mechanics," by Prof. L. R. Wilberforce; "A New Primer of Physics," by the same author.

Messrs. Cassell and Co., Ltd., give notice of:—A cheap monthly re-issue of the Century Science Series, edited by Sir Henry Roscoe, F.R.S.; "The Herschels and Modern Astronomy," by Agnes M. Clerke; "Pasteur," by Prof. Percy Frankland, F.R.S., and Mrs. Percy Frankland; "James Clerk Maxwell and Modern Physics," by R. T. Glazebrook, F.R.S.;

"Humphry Davy, Poet and Philosopher," by Dr. T. E. Thorpe, F.R.S.; "Major Rennell, F.R.S., and the Rise of Modern English Geography," by Sir Clements R. Markham, F.R.S.; "Justus Von Liebig: His Life and Work," by W. A. Shenstone, F.R.S.; "Charles Lyell and Modern Geology," by Prof. T. G. Bonney, F.R.S.; "John Dalton and the Rise of Modern Chemistry," by Sir Henry E. Roscoe, F.R.S.; "A Practical Method of Teaching Geography" (England and Wales, part ii.), by J. H. Overton; "Pictorial Practical Fruit Growing," a concise manual giving instructions for the management of every important fruit in cultivation, by W. P. Wright, illustrated; and re-issues of "Familiar Wild Birds," by W. Swaysland, illustrated, and "Cassell's Natural History," illustrated.

Messrs. J. and A. Churchill's list includes:—"A Treatise on Physics," by Prof. A. Gray, F.R.S., in three parts, illustrated, part i., Dynamics and Properties of Matter; "Gynæcological Pathology," by Dr. Charles Hubert Roberts, illustrated; "Diseases of the Thyroid Gland, and their Surgical Treatment," by Dr. James Berry, illustrated; "Handbook of Clinical Medicine for Practitioners and Students," giving an account of the diagnosis, prognosis and treatment of disease, by Dr. Thomas D. Savill, illustrated; and a new edition of "Carpenter's Microscope and its Revelations," edited by Rev. Dr. W. H. Dallinger, F.R.S., illustrated.

In the announcements of the Clarendon Press we observe:—"Micro-Anatomy," by G. Mann; "A Text-Book of Arithmetic," by R. Hargreaves; "Geometrical Exercises," by Prof. A. Larmor; "The Works of George Berkeley," edited by A. C. Fraser, 4 vols.; "The Ethics of Spinoza," by H. H. Joachim.

Messrs. Dent and Co. announce:—"Bird Watching," by E. Selous, illustrated.

Mr. Gustav Fischer (Jena) announces:—"Studien über die Narkose," by Dr. Overton; "Weiteres über Malaria. Immunität und Latenzperiode," by Dr. A. Plehn, illustrated; "Die Parasiten im Krebs und Sarkom," by Dr. Max Schüller, illustrated; "Das Gesetz der Güterconcentration in der individualistischen Rechts- und Wirtschaftsordnung," Erster Halbband: Das Gesetz der Güterconcentration und seine Bedeutung für die Wirtschaftspolitik, by Dr. J. Worms; and a new edition of "Die moderne Weltanschauung und der Mensch," by Dr. B. Vetter.

The announcements of Messrs. C. Griffin and Co., Ltd., include:—"The Construction and Maintenance of Vessels Built of Steel," by Thomas Walton, illustrated; "The Metallurgy of Steel," by F. W. Harbord, illustrated; "Hints on Steam Engine Design and Construction," by Charles Hurst, illustrated; "A Text-Book of Physics," by Profs. J. H. Poynting, F.R.S., and J. J. Thomson, F.R.S.:—"Properties of Matter," illustrated; "Tables and Data for the Use of Analysts, Chemical Manufacturers, and Scientific Chemists," by Prof. J. Castell Evans; "A Dictionary of Dyestuffs: A Compendium of Dyes, Mordants, and other substances employed in Dyeing, Calico-Printing, and Bleaching," by C. Rawson, W. M. Gardner, and Dr. W. F. Laycock; "A Dictionary of Textile Fibres," by William J. Hannan, illustrated; "Sanitary Engineering: A Practical Manual of Town Drainage and Sewage and Refuse Disposal," by Francis Wood, illustrated.

Messrs. J. Hall and Co. give notice of:—"Army Science Papers, being papers in chemistry, physics, physiography and geology, set in the Woolwich, Sandhurst and Militia Literary Examinations, 1890-1896"; "Army Mathematical Papers, being papers in arithmetic, algebra, Euclid, trigonometry and mensuration, set in the Sandhurst and Militia Literary Examinations (Class I.), 1890-1896," with answers by T. A. E. Sanderson.

Mr. W. Heinemann announces:—"A Universal History of Mankind," edited by Dr. Helmolt, vol. i. Introductory Pre-history—America and the Pacific Ocean; "Britain and the North Atlantic," by H. J. Mackinder.

Messrs. Hy. Holt and Co. (New York) will publish "The Anatomy of the Cat," by Profs. Reighard and Jenning, illustrated.

Messrs. Isbister and Co., Ltd., will issue:—"Nature and the Child," by C. B. Scott, illustrated; "Differential and Integral Calculus," with applications, by Prof. E. W. Nichols; "Experimental Chemistry," by Dr. Lyman C. Newell, Teacher's Supplement; Heath's Mathematical Monographs, issued under the general editorship of Prof. Webster Wells: (1-4) "Famous Geometrical Theorems and Problems and their History," by W. W. Rupert; (5) "On Teaching Geometry," by Florence Milner.

Messrs. Jarrold and Sons announce:—"Letters and Notes on the Natural History of Norfolk, more especially on the Birds and Fishes," from the MSS. of Sir Thomas Browne, M.D. (1605-1682), in the Sloane Collection in the Library of the British Museum, with notes by Thomas Southwell.

Messrs. Crosby Lockwood and Son promise:—"The Engineer's Year-book of Formulæ, Rules, Tables, Data and Memoranda in Civil, Mechanical, Electrical, Marine and Mine Engineering," by H. R. Kempe, illustrated; and new editions of "The Art of Soap-making: a Practical Handbook of the Manufacture of Hard and Soft Soaps, Toilet Soaps," by Alexander Watt, illustrated; "Pumps and Pumping, a Handbook for Pump Users, being Notes on Selection, Construction and Management," by M. Powis Bale; "Gas-Engine Handbook, a Manual of Useful Information for the Designer and the Engineer," by E. W. Roberts; "The Construction of Roads and Streets," by the late Henry Law and D. K. Clark.

Messrs. Longmans and Co.'s list includes:—"My Autobiography," by Prof. F. MaxMüller; "Researches on Cellulose, 1895-1900," by Cross and Bevan; "Human Personality, and its Survival of Bodily Death," by Frederic W. H. Myers, two vols.; "Dissertations on Leading Philosophical Topics: being Articles Reprinted from *Mind*," by Dr. Alexander Bain; "A Practical Treatise on Mine Surveying," by Arnold Lupton, illustrated; "Pianoforte Tone Production," by Prof. T. Matthay; "Twentieth Century Inventions: a Forecast," by George Sutherland.

Messrs. Macmillan and Co.'s science list comprises:—"The Cambridge Natural History," vol. viii., Amphibia and Reptiles, by Dr. H. Gadow, F.R.S.; "The Scientific Memoirs of Thomas Henry Huxley," edited by Prof. Sir M. Foster, K.C.B., F.R.S., and Prof. E. Ray Lankester, F.R.S., in 4 vols., vol. iii.; "Diseases in Plants," by Prof. H. Marshall Ward, F.R.S.; "The Problem of Conduct, a Study in the Phenomenology of Ethics," by A. E. Taylor; Macmillan's "A Manual of Medicine," edited by Dr. W. H. Allchin, vol. iii.; and new editions of "The Scenery of Scotland viewed in connection with its Physical Geology," by Sir Archibald Geikie, F.R.S., illustrated; "The Methods of Ethics," by the late Prof. Henry Sidgwick, with portrait; "Introduction to Physical Chemistry," by Prof. James Walker; "Flowers and Ferns in their Haunts," by M. O. Wright, illustrated; "Dictionary of Philosophy and Psychology," 3 vols., edited by Prof. J. M. Baldwin; "The Limits of Evolution," by Prof. G. H. Howison; "School Hygiene," by Dr. E. R. Shaw; "The New Basis of Geography," by J. W. Redway; "Ethics, Descriptive and Explanatory," by Prof. S. E. Mezes; "Cyclopedia of American Horticulture," edited by Prof. L. H. Bailey, vol. iii., illustrated; "The Principles of Stock-Breeding," by Prof. W. H. Brewer; "Farm Poultry," by Prof. G. C. Watson, illustrated; "The Principles of Feeding Animals," by W. H. Jordan; "A Laboratory Manual in Physics," by Drs. Crew and Tatnall; "Elementary Electricity and Magnetism," by Profs. D. C. and J. P. Jackson; "Plane and Solid Geometry," by Prof. A. Schultze and F. L. Sevenoak; "Elementary Geometry," by Prof. T. F. Holgate; "The Röntgen Rays in Medicine and Surgery," by Dr. F. H. Williams, illustrated; "Surgical Technique," by Drs. von Esmarch and Kowalzig (translated), illustrated.

Messrs. Methuen and Co. give notice of:—"The Natural History of Selborne," by Gilbert White, edited by Prof. L. C. Miall, F.R.S., and W. Warde Fowler; "Diseases of the Heart," by Dr. E. H. Colbeck, illustrated.

Mr. John Murray's list includes:—"The Native Races of South Africa: their Economic and Social Condition," by the South African Native Races Committee, with maps; "The Life of Gilbert White, of Selborne, based on letters, journals, and other documents in the possession of the family, and not hitherto published," by his Great Grand-Nephew, Rashleigh Holt-White, 2 vols., illustrated; "The Natural History of Religion, based on the Gifford Lectures delivered in Aberdeen in 1889-90 and 1890-91," by Prof. Edward Burnett Tylor, F.R.S., illustrated; "The Book of Ser Marco Polo, the Venetian," translated and edited by the late Colonel Sir Henry Yule, revised throughout in the light of modern discoveries, with a memoir of Colonel Yule," by Prof. Henri Cordier, 2 vols., illustrated; "Heredity," by Prof. J. Arthur Thomson,

illustrated; "The Dawn of Modern Geography, a history of exploration and geographical science from the opening of the Tenth to the middle of the Thirteenth Century, A.D., 900–1250," by C. Raymond Beazley, illustrated; "Dangerous Trades, the historical, social and legal aspects of industrial occupations as affecting public health," by a number of experts, edited by Dr. T. Oliver, illustrated; "The Gypsies of Spain, their Manners, Customs, Religion and Language," by A. Wallis Mills, illustrated.

Mr. J. C. Nimmo promises:—A new edition of "A Handbook of British Birds, showing the distribution of the Resident and Migratory Species in the British Islands, with an Index to the Records of the Rarer Visitants," by J. E. Harting, illustrated.

Mr. David Nutt calls attention to translations of:—"The Realms of the Dead in Ancient Egypt," by Prof. Alfred Wiedemann; "The Tell-el-Amarna Tablets," by Dr. C. Niebuhr; "The Babylonian and Hebrew Genesis," by Prof. H. Zimmern; "The Babylonian Conception of Heaven and Hell," by Dr. Alfred Jeremias; "The Political Development of Babylonia and Assyria," by Prof. H. Winckler.

Messrs. Kegan Paul and Co., Ltd., announce:—"The Origin of Thought," by Rev. D. Nickerson; "Arsenic," by Prof. J. A. Wanklyn.

Messrs. G. P. Putnam's Sons' announcements include:—"The Method of Evolution," a review of the present attitude of science toward the question of the laws and forces which have brought about the origin of species, by H. W. Conn, illustrated; "Care of the Consumptive," a consideration of the scientific use of natural therapeutic agencies in the prevention and cure of consumption, together with a chapter on Colorado as a resort for invalids, by Dr. Charles Fox Gardiner; and a new edition of "Thinking, Feeling, Doing," by E. W. Scripture, illustrated.

In the announcements of Messrs. Lovell Reeve & Co., Ltd., we notice:—"Flora Capensis," the continuation edited by Sir W. T. Thiselton-Dyer, F.R.S., vol. vi., part 1; "Flora of Tropical Africa," the continuation edited by Sir W. T. Thiselton-Dyer, F.R.S, vol. viii., part 1; "Monograph of Membracidæ," by George Bowdler Buckton, F.R.S.; "The Hepaticæ of the British Isles," by W. H. Pearson, parts 1 to 17; "The Lepidoptera of the British Islands," by Charles G. Barrett, part 79; "Lepidoptera Indica," by F. Moore, part 49; "Teracolus, a Monograph of the Genus," by E. M. Bowdler Sharpe, part 9.

Messrs. Walter Scott, Ltd., announce:—"The Mediterranean Race," by Prof. Sergi; and new editions of "Hypnotism," by Dr. A. Moll; "The Criminal," by H. Ellis; "The Evolution of Sex," by Profs. P. Geddes and J. A. Thomson; and "The Psychology of Religion," by Prof. Starbuck.

In the list of Messrs. Smith, Elder and Co., we see:—"Surgical Experiences in South Africa, 1899–1900, being mainly a Clinical Study of the Effects of Injuries produced by Bullets of Small Calibre," by George Henry Makins, illustrated.

The S. P. C. K.'s list includes:—"British and Garden Poisonous Plants," by Rev. Prof. Henslow.

Messrs. Swan Sonnenschein and Co., Ltd., announce:—"The Romance of the Heavens," by Prof. A. W. Bickerton, illustrated; "Phenomenology of the Spirit," by G. W. F. Hegel, translated by J. B. Baillie; "The Elements of Embryology, Man and Mammals," by Dr. O. Hertwig, translated and edited by Dr. E. L. Mark and H. W. Rand; "The Specious Present: a Metaphysical Treatise," by Alfred Hodder; "Student's Text Book of Zoology," by Adam Sedgwick, F.R.S., vol. ii., illustrated; "The Wonderful Century Reader," by Dr. Alfred Russel Wallace, F.R.S., illustrated; "Biological Types in the Vegetable Kingdom," by Wilfred Mark Webb; "Ethics," by Prof. W. Wundt, vol. iii.:—The Principles of Morality and the Sphere of their Validity, translated and edited by Prof. E. B. Titchener; "Physiological Psychology," by Prof. W. Wundt, translated from the fourth German edition by Prof. E. B. Titchener. 2 vols; "Aristotle's Psychology," translated and edited, &c., by Prof. W. A. Hammond; "History of Contemporary Philosophy," by Dr. Max Heinze, translated by Prof. W. Hammond; "The Life of the Sea Shore," by M. Newbiggin, illustrated; "Text-Book of Palæontology for Zoological Students," by T. T. Groom, illustrated; "Mammalia," by Rev. H. A. Macpherson; "Birds' Eggs and Nests," by W. C. J. R. Butterfield, and a new edition of "Evolution and its bearing on Religions," by A. J. Dadson.

The Science announcements of the University Tutorial Press are:—"First Stage Practical Plane and Solid Geometry"; "First Stage Machine Construction and Drawing"; "First Stage Building Construction," by Brysson Cunningham; "Mathematics, First Stage," Edited by Dr. Wm. Briggs; "First Stage Physiology"; "Section One Physiography"; "Key to Mechanics of Solids, First Stage," by F. Rosenberg; "Advanced Hygiene," by A. E. Ikin and R. A. Lyster; "The Tutorial Algebra," part i., Elementary Course, by Rupert Deakin; "The Tutorial Arithmetic," by W. P. Workman; "Deductions in Euclid," by T. W. Edmondson.

Mr. T. Fisher Unwin announces:—"In Tibet and Chinese Turkestan," by Captain H. H. P. Deasy, illustrated; "By Rock and Pool," by Louis Becke.

Mr. P. Wellby gives notice of:—A new edition of "Psychic Philosophy as the Foundation of a Religion of Natural Law," by V. C. Desertis.

Messrs. Whittaker's list is as follows:—"Electric Traction," by J. H. Rider; "Electric Lighting and Power Distribution," by W. Perren Maycock, vol. ii.; "Galvanic Batteries," by S. R. Bottone; "Telephone System of the British Post Office," by T. E. Herbert.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The subject for the Sedgwick Prize, 1903, is "The Petrology of some Group of British Sedimentary Rocks."

A John Lucas Walker Studentship in Pathology, of the value of £200 a year for three years, will shortly be filled up. Candidates, who need not be members of the University, are to apply to Prof. Woodhead, Pathological Laboratory, by April 16.

Mr. A. W. Hill and Mr. C. E. Inglis have been elected to fellowships at King's College. Mr. Hill took first classes in the Natural Sciences Tripos, 1897-98; Mr. Inglis was 22nd Wrangler, 1897, and first class Mechanical Sciences Tripos, 1898.

DR. KOHN, of University College, Liverpool, has been elected Principal of the new Sir John Cass Technical Institute, Aldgate.

THE Senate of the University of Aberdeen have decided to confer the honorary degree of LL.D. upon Prof. Virchow, of Berlin, Major Alfred W. Alcock, Superintendent of the Indian Museum, Calcutta, and Professor of Zoology in the Medical College of that city, and Dr. Angus Fraser, of Aberdeen.

THE celebration of the ninth jubilee of the University of Glasgow will begin on June 12, and will occupy three or four days. The details of the programme have not yet been arranged, but we understand that the celebration will probably include a religious service in the Cathedral, public reception of delegates and addresses from Universities and learned societies, a graduation ceremony, conversazione in the Bute Hall, banquet in the City Chambers, garden party in the Botanic Gardens, and a smoking concert. If the weather is fine there will also be an excursion down the Clyde by steamer.

SCIENTIFIC SERIALS.

American Journal of Science, March.—Circular magnetisation and magnetic permeability, by John Trowbridge and E. P. Adams. The experiments of Klemenčič upon the intensity of magnetisation produced by an oscillatory current in an iron wire, showed that for a frequency of 9×10^7 oscillations per second the permeability of iron to oscillatory currents is a constant. In the present paper the oscillation frequencies are much lower, ranging from 600 to 3000, and in this case the permeability is not a constant, but depends upon the strength of the magnetic field; that is, the iron behaves towards oscillatory currents in much the same manner as it does towards steady currents.—Notes on the geology of parts of the Seminole, Greek, Cherokee, and Osage nations, by C. N. Gould. A line of coal beds extends north and south near Bartlesville, Skiatook, Dawson, Tulsa, Okmulgee, and Henryville. There is no reason to doubt that gas and oil will eventually be found near these coal beds.—Names for the formations of the Ohio coal measures, by C. S. Prossner.—A new American species of Amphicyon, by J. L. Wortman.

A description of a palatal portion of a skull from the Loup Fork Miocene deposits of Nebraska, named *Amphicyon americanus*, which is undoubtedly to be referred to the European genus. All the Amphicyons of the American Tertiary hitherto described belong to genera quite different and distinct from the typical genus *Amphicyon* of Europe.—Studies in the Cyperaceæ, by T. Holm. *Carices* (*Vigneae*) *astrostachyae*.—A just intonation piano, by S. A. Hageman. A description of a piano mechanism for giving just intonation as opposed to equal temperament.—Very on atmospheric radiation, by W. Hallock.

Annalen der Physik, February.—The electromagnetic rotation experiment and unipolar induction, by E. Hagenbach. Lecher has described some results which have led him to regard the usual text-book explanations of many rotation experiments as fallacious. The experimental results here given are in complete accordance with the values calculated from the Biot-Savart laws, and, in fact, the fundamental experiment of Lecher furnishes an additional proof of their accuracy.—On the law of radiation of black substances, by F. Paschen. A comparison of the theories of Planck and Wein with experiment.—A new determination of the dispersion of fluorspar in the ultra-red, by F. Paschen.—The determination of the selective capacity for reflection of a plane mirror, by F. Paschen.—On the behaviour of liquid dielectrics on the passage of an electric current, by E. v. Schweidler. The results obtained show that the analogy between the behaviour of ionised gases and liquid dielectrics is not an accidental one, but is based upon the phenomena of discharge.—On the testing of the magnetic properties of steel, by I. Klemenčič.—Determination of the frequency of an alternating current, by R. Wachsmuth. The method described, which is very convenient for vibrations between 1 and 100 per second, ceases to be of service when the number rises above 150.—On the temperature in Geissler's tubes, by K. Kerkhof. The temperature in the capillary tube of a Geissler tube was measured by means of the change of resistance of a fine platinum wire. The results were not in agreement with Wiedemann's law, that the temperature is inversely proportional to the section of the tube.—Magnetic images, by H. Jaeger.—The experimental determination of the capillary constants of condensed gases, by L. Grunmach. The method used is based upon the production of capillary waves by the prongs of a tuning fork and the application of a formula developed by Lord Kelvin. It had been found previously to yield satisfactory results with ordinary liquids and molten metals, and has worked well with liquefied gases. Results are given for sulphur dioxide, ammonia, Pictet's liquid and chlorine. The application of the formula of Ramsay and Shields to these observations proves that there is no association of the molecules in liquid ammonia and sulphur dioxide. In the case of chlorine there appears to be a certain amount of association.—The motion of an electrified particle in an electrostatic field, by E. Riecke.—On stratification in a stream of electrified particles, by E. Riecke.—On the ionisation of electrified gases and the unipolar discharge in glowing bodies, by J. Stark.—On the thermoelectrical behaviour of some oxides and metallic sulphides, by E. van Aubel. The results do not confirm the researches of Abt on the same subject.—On the molecular heat of compound bodies and the Neumann-Joule-Kopp law, by E. van Aubel.—On the theory of radiation. A reply to the criticism of Planck, by W. Wien.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 28.—"On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. IV. The Seed-like Fructification of *Lepidocarpon*, a Genus of Lycopodiaceous Cones from the Carboniferous Formation." By D. H. Scott, M.A., Ph.D., F.R.S., Hon. Keeper of the Jodrell Laboratory, Royal Gardens, Kew.

A short account of the new genus *Lepidocarpon* has been given in a note communicated to the Royal Society last August [1]; the present paper contains a full, illustrated description of the fossils in question, together with a discussion of their morphology and affinities.

The strobilus of *Lipidocarpon Lomaxi*, the Coal-measure species, is, in its earlier condition, in all respects that of a *Lepidostrobus*, of the type of *L. Oldhamius*.

[1] "Note on the Occurrence of a Seed-like Fructification in certain Palæozoic Lycopods," *Roy. Soc. Proc.*, vol. lxvii. p. 306.

In each megasporangium, however, a single megaspore or embryo sac alone came to perfection, filling almost the whole sporangial cavity, but accompanied by the remains of its abortive sister-cells. An integument ultimately grew up from the sporophyll, completely enclosing the megasporangium, and leaving only a narrow slit-like opening, or micropyle, along the top. As shown in specially favourable specimens, both of *Lepidocarpon Lomaxi* and of *L. Wildianum*, the more ancient Burntisland form, the functional megaspore became filled by a large-celled prothallus, resembling that of the recent *Isoëtes* or *Selaginella*. The whole body, consisting of the sporophyll, bearing the integumented megasporangium and its contents, became detached from the strobilus, and in this isolated condition is identical with the "seed" described by Williamson under the name of *Cardiocarpon anomalum*, which, however, proves to be totally distinct from the Cordaitean seed so named by Carruthers.

The seed-like organs of *Lepidocarpon* are regarded by the author as presenting close analogies with true seeds, but as differing too widely from the seeds of any known Spermophyta to afford any proof of affinity. The case appears rather to be one of parallel or convergent development, and not to indicate any genetic connection between the Lycopods and the Gymnosperms, or other Phanerogams.

"On the Theory of Consistence of Logical Class-frequencies and its Geometrical Representation." By G. Udny Yule, formerly Assistant Professor of Applied Mathematics in University College, London. Communicated by Prof. K. Pearson, F.R.S.

Geological Society, February 20.—J. J. H. Teall, F.R.S., president, in the chair.—Prof. J. B. Harrison, alluding to a series of views of parts of the interior of British Guiana, which he laid on the table, remarked that the photographs had been taken by his colleague, Mr. H. I. Perkins, Acting Commissioner of Mines in British Guiana, during their recent geological investigations into the structure of the goldfields of that colony. The views well illustrate the general characteristics of the densely wooded country in which the gold-bearing areas occur, and give some idea of the difficulties which affect the work of the mining prospector and of the field-geologist in that colony. Several of the photographs illustrate rapids, cataracts and falls which so frequently occur along the courses of some of the vast rivers of that part of South America, and show the differing forms of weathering of various igneous rocks and of horizontally-bedded sandstones and conglomerates in the tropics. With reference to a few rock-specimens exhibited, Prof. Harrison stated that they were of diamond-drill cores from the Omai Creek claims on the Essequibo River, and that they fairly represented the principal auriferous rocks of that district. Omai Creek is a small stream flowing into the Essequibo at about 130 miles above its mouth, and the country through which it flows is usually diabase (dolerite) and its decomposition-products. From a part of the bed of one of the tributaries of this stream (Gilt Creek), about 500 feet in length by 50 in breadth, some 60,000 ounces of gold and some hundreds of small diamonds have been recovered by the somewhat crude methods of working hitherto in use.—Prof. Edward Hull made a communication, illustrated by lantern slides, on the submerged valley opposite the mouth of the River Congo. The position of this submerged valley has been ascertained by Mr. Edward Stallybrass and Prof. Hull by contouring the floor of the ocean with the aid of the soundings recorded on the Admiralty charts. The sides of the valley are steep and precipitous and clearly defined, the width varying from two to ten miles, and the length across the continental platform being about 122 miles. It is continuous with the valley of the Congo, and its slope is uninterruptedly downward in the direction of the abyssal floor. The steepness of the sides indicates that they are formed of very solid rocks. Several other submerged valleys off the coast of Western Europe were described for comparison. In most cases the landward end of the submerged river-channel is filled with silt, &c., for some distance from the mouth of the actual river; but farther out its course becomes quite distinct towards its embouchure at the edge of the continental platform. Among the valleys specified were those off the mouth of the Tagus and the Lima, the Adour and the Loire, and those in the English and Irish Channels. The following communication was read:—The geological succession of the beds below the Millstone Grit series of Pendle Hill and their equivalents in certain other parts of England, by Dr. Wheelton Hind and J. Allen Howe. Part i. of this paper

consists of a detailed account of the ground. By various sections the extent of the deposit is shown, and it is demonstrated that the deposit occupies a basin, of which the Pendle district occupies the maximum area of deposit, for the sequence thins out rapidly north-west and south. But although the beds thin out, a calcareous series with a typical zonal fauna is always present. Beds containing this fauna are traced from County Dublin, the Isle of Man, Bolland, Craven, the Calder and Mersey valleys, to Derbyshire and North Staffordshire. It is shown that this series, for which the term Pendleside Series is proposed, occupies a basin about the size of the area indicated above, and that the beds are lithologically distinct from the Yoredale Beds of Wensleydale, and contain a different fauna. Part ii. discusses the question in detail, from a palæontological point of view. The migration of certain families of fossils from the north to the south, brought about by a slow change of environment, is shown by tables, and lines called "isodiectic lines" are drawn to represent this distribution. It is shown that the Nuculidæ are found in the lowest Carboniferous beds in Scotland, but come in at successively higher horizons as the beds range southward. These facts and comparative thicknesses are the basis of an argument as to the local distribution of land and water in Carboniferous times; and it is shown that the peculiar change in type which Carboniferous rocks undergo in passing from north to south is due entirely to physiographical conditions, and not to any theoretical assumption of contemporaneous faulting. It is shown, moreover, that the Craven Faults *per se* have had nothing to do with this change of type. The correlation of the limestone-knolls of Craven with the Pendleside Limestone is demonstrated to be no longer tenable.

Zoological Society, March 5.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—Mr. Sclater exhibited, on behalf of Captain Stanley Flower, photographs of a young female giraffe, a young male white oryx (*Oryx leucoryx*), and a male ostrich, with the vocal sac extended, which had been taken from examples living in the Zoological Garden at Ghizeh, Egypt.—There were exhibited, on behalf of Dr. Einar Lönnberg, two photographs of a skull of the musk-ox from East Greenland.—Dr. Smith Woodward read a paper on some remains of extinct reptiles obtained from Patagonia by the La Plata Museum. They included the skull and other remains of a remarkably armoured Chelonian, *Miolania*, which had previously been discovered only in superficial deposits in Queensland and in Lord Howe's Island, off the Australian coast. The genus was now proved to be Pleurodiran. There was also a considerable portion of the skeleton of a large extinct snake, apparently of the primitive genus of the South American family Ilysiidæ. Along with these remains were found the well-preserved jaws of a large carnivorous Dinosaur, allied to *Megalosaurus*. Either the dinosaurian reptiles must have survived to a later period in South America than elsewhere, or geologists must have been mistaken as to the age of the formation in which the other reptiles and extinct mammals occurred. The discovery of *Miolania* in South America seemed to favour the theory of a former Antarctic continent; but it should be remembered that in late Secondary and early Tertiary times the Pleurodiran Chelonians were almost cosmopolitan. Future discovery might thus perhaps explain the occurrence of *Miolania* in South America and Australia, in the same manner as the occurrence of *Ceratodus* in these two regions was already explained.—Mr. R. I. Pocock read a paper containing descriptions of six new species of trap-door spiders from China. One of these, *Haloproctus ricketti*, was remarkable as constituting a new genus of a specialised group of Ctenizidæ, hitherto known only from the Sonoran area of North America. Another, *Latouchia fossoria*, also a new genus, was a more typical Ctenizoid.—Mr. R. H. Burne read a paper on the innervation of the supraorbital canal in the sea-cat (*Chimaera monstrosa*).—Mr. F. E. Beddard, F.R.S., read descriptions of certain new or little-known earthworms belonging to the genera Polytoreutus and Typhœus. Mr. Beddard also described the clitellum and spermatophores in the annelid *Alma stuhlmanni*.

EDINBURGH.

Royal Society, February 18.—Prof. Geikie in the chair.—Dr. Peddie communicated a paper by the late Mr. Shand and himself on the thermoelectric position of solid mercury. The thermoelectric line was found to be nearly parallel to that of iron and to meet the line of copper very near the temperature of $-50°$ C.—Mr. Thomas Heath read a paper on observations of the Edinburgh rock thermometers, in which the observations both of the old and the new sets were fully discussed. There was some doubt about the corrections to be applied to the new set; but treating them in the same way as the old set which had been installed by Prof. Forbes in 1837, but had been broken in 1876 by a madman, Mr. Heath found that the results were fairly consistent. There was evidence of change of conductivity with depth, and the values of the conductivity deduced by him from the harmonic analysis were somewhat smaller than the values deduced by Forbes and Everett from the older observations. The new thermometers, however, had been steadily sinking in position since they had been installed in 1879.

March 4.—Sir Arthur Mitchell in the chair.—Prof. Letts and Mr. J. Hawthorne communicated a paper on the seaweed *Ulva Latissima* and its relation to the pollution of sea water by sewage, in which they had investigated with care the manner of fermentation under various conditions. One of the most remarkable facts about this seaweed is the high proportion of nitrogen, distinctly in excess of what is met in other similar plants, in this respect resembling an animal rather than a plant. *Ulva Latissima* is found in great quantity in certain parts of Belfast Lough and Dublin Bay, where the water is strongly polluted by sewage. In similar situations in Stranford Bay, where there was comparatively little sewage, the weed was rarely met with.—Mr. Aitken, in some further notes on the dynamics of cyclones and anticyclones, discussed the relation between storm tracks and the regions of maximum temperature and maximum humidity. Four facts were mentioned as supporting the theory that cyclones were convectionally driven, namely: (1) the circulation in cyclones is principally towards the centre, (2) the velocity increases towards the centre at all levels, (3) storm tracks form and follow with the season change of the areas over which the supply of hot moist air is most plentiful, (4) the greater violence of winds in cyclones than in anticyclones points to some source of energy in cyclonic areas. —Prof. Copeland, the Astronomer Royal for Scotland, gave an account of the observations of the new star in Perseus, discovered by Dr. Anderson. Since the first night of observation the character of the spectrum of the star had changed greatly, being now a faint continuous spectrum crossed with broad, bright lines, flanked on the more refrangible side with dark absorption bands. No evidence of polarisation could be detected in the bright lines. The star was now on the wane, and would probably gradually diminish in brightness until it ceased to be visible to the naked eye. In the after discussion Dr. Knott pointed out how the distribution of the bright and dark bands fell in with the view that the phenomenon was due to a collision taking place mainly in the line of sight, the later stages requiring the relative displacement towards us of gaseous products, cooling by their expansion.

MANCHESTER.

Literary and Philosophical Society, March 5.—Prof. Horace Lamb, F.R.S., president, in the chair.—Mr. C. E. Stromeyer referred to the results of a study of tidal waves which he had published in NATURE in 1895, and which indicated that in the majority of cases of which records were available the tidal waves appeared to proceed from the Faraday Reef. Particulars of the tidal wave which recently struck the *Teutonic* are not yet to hand for comparison with former records.—Mr. W. E. Hoyle read a paper entitled "On the genera Octopus, Eledone and Histiopsis," in which he dealt with the nomenclature of these genera.

PARIS.

Academy of Sciences, March 11.—M. Fouqué in the chair.—Utilisation of the points of Collins for the determination of a quadrilateral, by M. Hatt.—On the complete synthesis of acetylpropylene and the terpenic hydrocarbons, by M. Berthelot. Propylene and acetylene, mixed in equal volumes, are heated together to about 500° C. The hydrocarbon C_5H_8 is formed, together with methane.—Remarks on my last communication relating to the telegraphic and telephonic lines established on the snow of Mont Blanc, by M. J. Janssen.—On the waves of the second order, with respect to the velocities which may be presented by a viscous fluid, by M. P. Duhem.—Maltosuria in certain diabetics, by MM. R. Lépine and Boulud. The difference between the rotatory power and the copper-reducing power in the case of certain urines from diabetic patients can be explained by the assumption that maltose is present as well as

glucose.—Remarks by M. Edmond Perrier, on the scientific expeditions of the *Travailleur* and *Talisman*.—M. A. Normand was elected a correspondant for the Section of Geography and Navigation in the place of M. Alexis de Tillo.—Remarks by M. Darboux on the death of M. Th. Moutard.—On the variability of the planet *Eros*, from negatives taken at the Observatory of Toulouse, by M. L. Montangerand (see p. 502).—Note concerning the preceding observations of M. Montangerand, by M. Baillaud.—Complementary details on the new star in Perseus, by M. H. Deslandres. The results of the spectroscopic study of the new star do not confirm the hypothesis tentatively put forward in a previous note. It appears to be necessary to assume the existence of at least two stars, one of which is perhaps a nebula, and which is approaching the other with an enormous velocity.—Observations on the sun made at the Observatory of Lyons with the Brunner 16 cm. equatorial during the fourth quarter of 1900, by M. J. Guillaume. The results are summarised in three tables, giving the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—On a certain category of transcendental functions, by M. Edmond Maillet.—On the regular quaternary groups of a finite order, by M. Léon Autonne.—On an electrophone giving very loud sounds and on the causes which produce it, by M. Th. Tommasina.—On the reduction of sulphomolybdic acid by alcohol, by M. E. Péchard. Molybdic acid, dissolved in sulphuric acid and gradually reduced by alcohol, gives a blue crystalline deposit of complicated composition, approximately $5NH_3MoO_2SO_3.7MoO_3+8H_2O$.—A new glycol, 1-4 butane-diol, or tetramethyleneglycol, and its diacetin, by M. J. Hamonet. The diacetin is prepared by the action of silver acetate upon the di-iodobutane, and the glycol is obtained from this by heating with dilute lime-water.—The action of zinc powder upon the saturated fatty acids, by M. A. Hébert. Stearic acid, heated with zinc dust, gives a complicated mixture of olefines, the bromides of which were examined.—The action of mercuric oxide upon some organic compounds, by MM. A. Lumière, L. Lumière and F. Perrin.—On a new preparation of terpinol, by M. P. Genvresse. Pinene, dissolved in alcohol, is treated with nitrous acid, distilled with steam and the product purified by fractional distillation in a vacuum.—New characters of the short electrical stimulus transmitted by the nerve, by M. Aug. Charpentier.—Contribution to the psycho-physiological study of the vital acts in the total absence of the brain in an infant, by MM. N. Vaschide and Cl. Vurpas. The infant, which survived thirty-nine hours, showed a notable lowering of temperature and remarkably slow breathing of the type described by Cheyne and Stokes. The case demonstrated the *rôle* of the cerebral hemispheres in circulation, respiration and the temperature regulation.—New observations on *Bathyomus*, enormous isopods met with at great depths, by M. E. L. Bouvier.—On the sensibility of the higher plants to very small doses of toxic substances, by M. Henri Coupin. The higher plants, like the fungi, are so sensitive to the toxic action of certain metals, notably silver, mercury, copper and cadmium, that they give evidence of their presence in quantities too small to appreciate by chemical analysis.—Anatomical researches on the ripening of the shoots of the vine, by M. Kövessi. The branches ripen better as the cellular thickness of their walls increases and as their cells contain more starch.—On a fossil insect found in the Trias of Lorraine, by M. P. Fliche.—On the periods of the southern aurora, by M. Henryk Arçtowski.—Note relating to a lithological and bathymetric atlas of the coasts of France, by M. J. Thoulet.

DIARY OF SOCIETIES.

THURSDAY, MARCH 21.

ROYAL SOCIETY, at 4.30.—Studies in Visual Sensation (Croonian Lecture): Prof. C. Lloyd Morgan, F.R.S.

LINNEAN SOCIETY, at 8.—On the Intestinal Tract of Birds, and the Valuation and Nomenclature of Zoological Characters: P. Chalmers Mitchell.

CHEMICAL SOCIETY, at 8.—Researches on Morphine, Part II: S. B. Schryver and F. H. Lees.—The Constitution of Pilocarpine, Part II.: H. A. D. Jowett.—Note on the Latent Heats of Evaporation of Liquids: Holland Crompton.—(1) Action of Dry Silver Oxide and Ethyl Iodide on Benzoylacetic Ester, Desoxybenzoin, and Benzyl Cyanide; (2) Alkylation of Acylarylamines: G. D. Lander.

CAMERA CLUB, at 8.15.—Yorkshire Caves and Waterfalls: T. C. Hepworth.

FRIDAY, MARCH 22.

ROYAL INSTITUTION, at 9.—Some Recent Work on Diffusion: Dr. Horace Brown, F.R.S.

PHYSICAL SOCIETY (University College, Gower Street), at 5.—On the Expansion of Silica: Prof. Callendar, F.R.S.—The Spectroscopic Apparatus at University College: Dr. E. C. C. Baly.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Hunslet Railway and Bridge over the River Aire: O. L. McDermott.

SATURDAY, MARCH 23.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

MONDAY, MARCH 25.

SOCIETY OF ARTS, at 8.—Electric Railways: Major P. Cardew.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journeys in the Linyanti Region, South Africa: Percy C. Reid.—Exploration and Survey in the Sobat Region: Major H. H. Austin, R.E.

INSTITUTE OF ACTUARIES, at 5.30.—On the Rates of Mortality in New South Wales and Victoria, and the Construction of a Mortality Table from a single Census and the Deaths in the Years adjacent thereto: E. McMahon Moors and W. R. Day.

CAMERA CLUB, at 8.15.—Colour Photography by the Sanger-Shepherd Process: A. Pringle.

TUESDAY, MARCH 26.

ROYAL INSTITUTION, at 3.—The Cell as the Unit of Life: Dr. A. Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: The Æsthetic Treatment of Bridge Structures: J. Husband.—*Paper to be read, time permitting*: The Burrator Works for the Water-supply of Plymonth: E. Sandeman.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Some Improvements in Optical Projection: J. H. Agar Baugh.

WEDNESDAY, MARCH 27.

SOCIETY OF ARTS, at 8.—Clocks, Carillons and Bells: A. A. Johnston.

THURSDAY, MARCH 28.

ROYAL SOCIETY, at 4.30.—*Probable papers*: The Growth of Magnetism in Iron under Alternating Magnetic Force: Prof. E. Wilson.—On the Electrical Conductivity of Air and Salt Vapours: Dr. H. A. Wilson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electrical Transmission of Power in Coal Mines: H. W. Ravenshaw.—Portable Electric Lamps: S. F. Walker.

CHEMICAL SOCIETY, at 3.—Annual General Meeting.

FRIDAY, MARCH 29.

ROYAL INSTITUTION, at 9.

SATURDAY, MARCH 30.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

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THURSDAY, MARCH 28, 1901.

THE BOOK OF ANTELOPES.

The Book of Antelopes. By P. L. Sclater and O. Thomas. 4 vols. Illustrated. (London: Porter, 1894–1900.) Price, 13*l.* 10*s.* net.

IT was the intention of the late Sir Victor Brooke, who for many years of his life devoted a large amount of time and attention to the study of the ruminants generally, to write an illustrated monograph of that interesting and beautiful, although ill-defined, section of them commonly known as antelopes. And with this end in view he instructed the late Mr. Joseph Wolf to prepare a number of coloured sketches of these animals, which were in due course transferred to stone, printed off, and coloured by hand. A considerable bulk of manuscript was also written by Sir Victor; but, for some reason or another, the work was never brought to anything like completion during his lifetime.

And perhaps it was fortunate for science that the material thus accumulated was left in this unfinished state. For the opening-up of Somaliland and East Africa in general, as well as continued exploration in the heart of the continent, have of late years made us acquainted with quite a number of antelopes which were altogether unknown, or but very imperfectly known, to Sir Victor Brooke, so that if the work had been published during his lifetime it would necessarily have been extremely incomplete and imperfect.

By the generosity of Sir Victor's executors the whole of these drawings, plates and manuscript were unreservedly placed at the disposal of the senior author of the splendid volumes before us, who for many years had made constant endeavours to increase our knowledge of the antelopes of Africa, and by whom many remarkable new types had been brought to the notice of the zoological world. As the work would have been too heavy for a man with as many calls on his time as has the secretary of the Zoological Society to carry out alone, Mr. Sclater secured the assistance of Mr. Thomas, of the British Museum. Such additional plates as were necessary to complete the series of the more striking types of antelopes were duly put in hand and completed. And the result of this happy union of forces has been, after several years of arduous labour, to produce a work the like of which has never before been seen, and which will remain a monument alike of the ability and industry of its authors and of a group of lovely animals which are only too rapidly and too surely disappearing for ever before the advance of an all-devouring civilisation.

Despite the fact that the new sketches lack the inimitable touch characteristic of Wolf's animal pictures, they accord fairly well with lithographic reproductions of the latter, and in certain instances are their superior in truthfulness to nature. For in sketches of this description there is always a danger lest fidelity to the model should be sacrificed to artistic effect, an instance in point occurring in the case of Mrs. Gray's waterbuck of the White Nile.

Although coloured figures of a number of the more striking South African antelopes appeared in the well-known sporting work by the late Sir Cornwallis Harris, while Dr. Gray, in the British Museum "Catalogue of Ruminant Animals," published in 1872, gave a complete list of the species then known to him, no fully illustrated monograph of this group of ruminants has, we believe, ever previously been published—at least in this country—so that the authors have the field practically to themselves. In Gray's Catalogue a total of 101 species of these animals were recognised, of which no less than 81 are African; but in a "Hand-list" published a year later the number was reduced to 98, owing to three of the African names having been found to be synonyms of others. In the present monograph, the authors, apart from a few described during the progress of the work, recognise a total of no less than 133 distinct species, about 120 of which are African. It is true that certain of these so-called species might be regarded by other naturalists (now possibly in some instances by the authors themselves) in the light of local races; but, even making allowance for such possible reductions, the increase in the number of well-established species of these animals since the date of Gray's last list is very noteworthy, and bears eloquent testimony to the energy with which African zoology has been worked up of late years. As the great majority of these new species have been described by one or other of the authors, it was only right and proper that the task of monographing the entire group should have fallen to their lot.

Although most of us have a general and vague idea of what constitutes an "antelope," yet it is somewhat remarkable that the group of animals thus designated is one that does not admit of accurate limitation or definition. Some, for instance, might consider that the chamois and the so-called white goat of the Rocky Mountains were entitled to be included in the group; but this is not the view held by the authors of the present monograph. As a matter of fact, the term is only a vague designation for a number of more or less distinct groups of hollow-horned ruminants which come under the designation neither of cattle, sheep nor goats; and in reality there ought to be a distinct English group-name for each subfamily into which "antelopes" are subdivided by our authors. But we must take things as we find them, and such subdivisions being impossible in colloquial language, we cannot do better than agree to employ the term "antelopes" in the sense in which it is used by the authors; that is to say, as indicating the animals treated of in this work, and no others.

As they have occasion to use it so frequently, it is perhaps a little remarkable that the authors have apparently made no attempt to trace the origin and derivation of the word "antelope." So far as can be determined it appears, however, to trace its origin, through the Latin, to *Pantholops*, the old Coptic, and *Antholops*, the late Greek name of the fabled unicorn. Its adoption by the languages of Europe cannot apparently be traced further back than the fourth century of our era, at which date it was employed to designate an imaginary animal living on the banks of the Euphrates. By the earlier English naturalists, and afterwards by Buffon, it was, however, applied to the Indian blackbuck, which is thus entitled to rank as *the* antelope. It follows that the subfamily typified by this species, in which are included the

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gazelles, is the one to which alone the term antelopes should be applied if it were employed in a restricted and definable sense.

In their classification, the authors follow in the main the divisions sketched out by Sir Victor, although they have somewhat increased the number of sections, or subfamilies, into which this assemblage of ruminants is split up. Into the limits of such sections it is quite unnecessary to enter upon the present occasion, as it is into any details with regard to species. In the main the characters of most of the species have been drawn from the magnificent series of skins in the British Museum; and where this is the case no emendation on the diagnosis given by the authors is ever likely to be required. In a few instances, however, the Museum was possessed of only very inadequate material at the date when the descriptions were written, so that in these cases there is room for revision. An instance in point is afforded by the white-eared kob of the swamps of the Upper Nile, complete specimens of which have recently been presented to the Museum. By means of these it has been ascertained for the first time that the old bucks of this handsome species are deep black, at least during the pairing season.

Nomenclature, again, is a subject on which some change of opinion has taken place among naturalists during the period in which this work has been in progress. And it is probable that one at least of its authors would not now be prepared to defend the use of all the technical names therein employed.

Although the authors have to deplore the vast decrease that has taken place in the numbers of so many species of African antelopes, in only one instance (that of the blaauwbok) have they to lament complete extermination, and that is not chargeable to the present, or even to the last two or three generations. They record, however, that several species in South Africa are only kept in existence by special protection; and in this connection it may be observed that the effect of the present troubles in that region on these dying species must be watched with the utmost anxiety by all naturalists.

As regards the manner in which the descriptions of the various genera and species are drawn up, the reputation of the authors is a sufficient guarantee that this is, in the main, beyond criticism. And no effort appears to have been spared in order to acquire as much information as possible with regard to geographical distribution. As neither of the authors (except, perhaps, the junior in his youthful days) is acquainted with the animals described in their native wilds, recourse has been necessitated to the writings of others; and the authors may be congratulated that in most instances they have had the courage to give these borrowed accounts in their original guise, instead of endeavouring to conceal their source by paraphrasing.

In one respect, and in one respect only, is there cause for regret in connection with this undertaking, namely, that the authors have not seen fit to refer, or at least in any detail, to the comparatively little that is known in relation to the past history of the group of which they so ably treat. The description and definition of species (even if they be the chief points of interest to sportsmen) are most important, but they are, and can be, only comparatively insignificant features in the philosophical study of animal life and its meaning. One of the burning questions of the day (in zoological circles) is the origin of the Ethiopian fauna; whether it is endemic in the land from which it takes its name, or whether it is due to an immigration from more northern climes. As remains of species closely allied to the giraffes and antelopes of modern Africa are met with in the later Tertiary deposits of India, Persia and Greece, it is obvious that the groups mentioned have much connection with the solution of this important problem. It is, therefore, greatly to be regretted that the authors have not seen fit to give their own views on this point, so far as the evidence to be derived from antelopes is concerned, or, at all events, that they have not informed their readers that several of the genera of these animals, now restricted to Ethiopian Africa, formerly enjoyed a much more extensive geographical range.

In the prospectus to the work it is stated that the authors "are desirous of making the book interesting and instructive to the naturalist, sportsman and general reader." While maintaining throughout a high standard of scientific excellence, and refraining from lowering their style by the inclusion of so-called purely "sporting" accounts, which are only too frequently most wearisome and distasteful to the cultured reader, the authors may be congratulated on having succeeded in their intentions in a manner deserving of the heartiest commendation on the part of all to whom this splendid and monumental work appeals.

R. L.

THE SCIENCE OF ORE DEPOSITS.

Lehre von den Erzlagerstätten. By Dr. Richard Beck. ii Theil. Pp. ix–xviii + 385–724. (Berlin: Borntraeger, 1901). Mk. 8.50.

WE are thankful to find that Dr. Beck has not kept us waiting an unduly long time for the concluding portion of his valuable work, the first instalment of which was recently reviewed in these pages (see p. 245 January 10). The first part brought the description of the different classes of mineral deposits nearly up to the end of Fissure Veins; this subject is now brought to a conclusion with a number of general observations on this important group of ore deposits, the only criticism upon which need be that their limitations are somewhat too narrowly drawn. Most of the phenomena here described, such as the formation of gossans, enrichment or impoverishment of ores in depth, effects upon the surrounding "country," &c., are by no means confined to fissure veins, but are common to all classes of mineral deposits, depending as they do essentially upon the chemical composition of the mineral contents of the deposit, and either not at all or only in very remote degree upon its genetic relations or morphological features. The alterations and oscillations of mineral constitution that many veins show in depth are well but briefly described, although, perhaps, their close connection in many cases with changes in the country rock is hardly enough insisted on. It is almost certain that the well-known change in depth in the silver and copper contents of the Montana copper deposits is purely a

secondary phenomenon, and Dr. Beck is most probably in error when he ranks this among the primary modifications of ore deposits. The description of secondary alterations of deposits and the formation of gossans is extremely good, the chemical investigation of the subject being especially convincing. It must be noted that Dr. Beck only refers under this head to secondary changes above the permanent water-level (in the region of Pošepny's vadose circulation) and not to the phenomena which have recently attracted so much attention in America, and which, under the head of Secondary Enrichment of Ore Deposits, have been so ably investigated by Emmons, Weed and others; these Dr. Beck appears to omit entirely.

The section on the alteration of the wall rocks of mineral veins either by the influence of these veins themselves or by the agencies that have played an important part in the deposition of the mineral constituents of these veins, is a valuable summary of a very important subject, which has only in comparatively recent years attracted the attention that it deserves.

Coming next to the classification of other mineral deposits, or as Dr. Beck rather awkwardly designates them, "Not vein-like epigenetic ore deposits within stratified rocks," the subdivision is far from satisfactory. They are divided, first of all, as follows:—

A. Epigenetic ore beds.
B. Epigenetic ore masses.
C. Contact-metamorphic ore deposits.
D. Ore-bearing fillings of cavities.

Unfortunately, the first group contains many deposits that are generally looked upon as typical masses, *e.g.* the lenticular masses of cupriferous pyrites of the Huelva region. The group is subdivided into deposits occurring in crystalline strata and deposits in non-crystalline strata formed by impregnation, each class being then again subdivided according to its mineral contents. This classification is unfortunate, as it causes the author to describe the above-mentioned pyrites deposits as produced by impregnation; it would hardly be possible to assign a less probable genesis to such deposits as these, consisting as they do mainly of dense massive pyrites practically free from gangue, and it seems impossible to imagine that any one who has ever studied these deposits can seriously believe that they owed their origin to impregnation. It is in any case most unlikely that a system of classification that forces these deposits and the Norwegian and other similar pyrites deposits into different groups, and that takes, moreover, no account of the eruptive rocks with which they are so closely associated, can possibly be correct.

The group of Epigenetic ore masses is a rather more coherent one than its title implies, Dr. Beck confining this group to irregular deposits in calcareous rocks. It is perhaps doubtful whether this is the right place for those very puzzling deposits that are generally spoken of as the gold-bearing "reefs" of Pilgrim's Rest, Lydenburg; it is perhaps more likely that these will prove ultimately to be true bedded deposits, though their real character is to-day far from clear.

The next division of the book contains a short but good description of alluvial deposits; the objections to the independent treatment of this group of deposits have already been pointed out. Apart from these, Dr. Beck's descriptions are thoroughly satisfactory.

The work concludes with a brief but good chapter of general hints upon the search for mineral deposits. In this the author attempts, and with considerable success, to show that the scientific study of mineral deposits can give information of the greatest value to prospectors, and that his subject accordingly possesses, not merely a scientific and academic, but also a technical and commercial interest that should not be overlooked. This last chapter may more especially be recommended to the large number of mining engineers in this country who appear to think that the study of mineral deposits is one that they can venture to neglect as of no practical importance.

It is satisfactory to find that the wish expressed in the review of the first part of this book has been gratified, and that it is furnished with a good topographical as well as a general index, and it is a pleasure to be able to congratulate Dr. Beck on the production of a work of standard value upon the fascinating subject that he has done so much to advance. HENRY LOUIS.

ORGANIC CHEMISTRY.

Practical Organic Chemistry for Advanced Students. By Dr. Julius B. Cohen. Pp. xi + 284. (London: Macmillan and Co., Ltd., 1900.) Price 2*s.* 6*d.*

IN this enlarged edition Dr. Julius Cohen has increased greatly the value of the book as a manual for advanced students by adding chapters on organic analysis and the determination of the molecular weight. Under the latter heading we are glad to see he describes the preparation of the silver salts of organic acids and of the platinum salts of bases—two operations the description of which is frequently omitted from similar works. The appendix, which treats of the theory in the form of a note on each preparation, has also been enlarged. Our experience has been that students will not trouble to hunt theory in the limbo of an appendix, and the matter of these notes would have been more usefully incorporated in the preparations themselves. The explanations are necessarily condensed and frequently difficult to understand; for example (p. 193), "Aldehydes can only be obtained directly from the fatty acids by distilling the calcium salt with calcium formate; *but in no case by direct reduction, unless in the form of lactones.*"

The preparations are well and clearly described, and the apparently obvious is not ignored. Thus we read (p. 43), "A small balance with celluloid pans, for use on the bench, is indispensable." Such a balance is invariably used by German students in order to estimate their yields, but is a sufficiently rare object in an English laboratory.

Details of the preparation of ninety-seven substances are given, and consequently the book will be of great service, not only to the student, but also to the lecturer. Of the fifty-six substances usually prepared by the honour students at the Owens College, fifty-two are to be found in this book.

In a useful series of "Hints on the investigation of

organic substances" (p. 265) Dr. Cohen has made a most praiseworthy attempt to systematise the analysis of organic substances. This part of the book might advantageously have been expanded (if necessary at the expense of the appendix), when the futility of the closing hint[1] might have been avoided.

The old method for the preparation of diethyl malonate—the *pons asinorum* of the organic chemist—is still given, but a better yield is obtained by the method of Noyes (*Journal* of the American Chemical Society, 18, 1105, 1896); succinic acid melts at 185°, not 180°; the conversion of citraconic into mesaconic acid (p. 112) is due to Fittig, not to Jacobson; methyl oxalate (Prep. 24) is not indexed; and the preparation of kreatinine might advantageously have been omitted.

We must, however, congratulate Dr. Cohen on having produced the best elementary book, in the English language, on practical organic chemistry, and we have found that our students use the book with great confidence and are perfectly able to prepare any of the substances from the descriptions. The book, which is well printed and free from typographical errors, should rank with the similar works of Ludwig Gattermann in German, and of Dupont and Freundler in French.

W. T. L.

[1] ["2, *Solids*.—A mixture of solids may be separated either by use of a suitable solvent which will dissolve one of the constituents more readily than the other, or by means of one of the reagents described above" p. 272)].

OUR BOOK SHELF.

Description of the Human Spines, showing Numerical Variation, in the Warren Museum of the Harvard Medical School. By T. Dwight, M.D., LL.D. (Memoirs of the Boston Society of Natural History). Vol. v. No. 7. Pp. 75. (Boston, U.S.A., 1901.)

THIS memoir is for the greater part a careful description, with elaborate tabulation and adequate illustration, of forty-five anomalous human back-bones which, with one exception, were obtained during many years spent by the author in the dissecting-room of the Harvard Medical School. In the introductory portion of the work the author discusses Rosenberg's methods and well-known theory of "concomitant variations," based on the appreciation of a tendency of the cervical and lumbar regions of the column to absorb into themselves the thoracic, with change progressive and retrogressive at the opposite ends of this. Accepting, without proof, the theory that the human ilium enters into relation with different vertebræ during development, the author passes on to the consideration of irregular segmentation, and a discussion of the views of Baur, Bateson and others on inter- and ex-calation, deferring the latter author's theory of "homœosis" for consideration in the body of the work. He finally denies the existence of a precise number of lumbar vertebræ, and finds refuge in Welcker's theory of the *vertebra fuleralis*. With this as a determining factor he largely deals, and the most interesting portion of his memoir is that in which he shows it to be the twenty-fourth vertebra in each of seven examples lacking one of the præsacral series. He classifies his specimens into classes, and clearly, systematically formulates the individual spines of each, and deals in some cases with correlated modification of the spinal nerves. Arguing that the "essential part of the office of the spine is to form the median support of the trunk," he deduces what he terms a "vitalistic conception," viz., that parts in corresponding situations exhibit a tendency to develop in a corresponding manner; and in finally discussing Rosenberg's view, he remarks that its success has been largely due to the fact that "it fitted in so perfectly with the doctrine of descent by gradual modifications," and gives as his opinion that, "unfortunately for science," it has "become too much the custom to make everything square with this."

The memoir as a whole is laborious, but accurate and systematic, and will be of great use to the working anthropotomist. There is appended a description of some incomplete specimens of interest in the author's collection, and we would remind him that among the quadrupedal mammals co-ossification of the atlas vertebra with the skull is at times found to be an effect of dislocation, and would recommend to his consideration the recent description by Broom of an Echidna's spine having eight cervical vertebræ, and his discovery that in some marsupials the fourth lumbar and anterior caudal vertebræ bear in the young state free ribs.

Where Black Rules White: A Journey across and about Hayti. By H. Prichard. Pp. 288. (Westminster: Archibald Constable and Co., Ltd., 1900.) 12s.

MR. PRICHARD visited Haïti in the year 1899 as a special correspondent of the *Daily Express*; and in the volume under notice we have his impressions and experiences described, with anecdotes and illustrations. He made a short trip into Santo Domingo, to which he devotes a chapter, but otherwise the book is concerned with the people, places and affairs of the part of the island governed by the Haïti Republic. Referring to the people of the Dominican State, Mr. Prichard remarks: "They are not nearly so likeable as the Haytian peasantry, and hospitality does not flourish in the same degree as on the western side of the border. On the other hand, the Government of San Domingo is less jealous of foreign influence. The Dominicans speak Spanish, and have preserved the purity of their language to a far greater degree than can be said of the Haytians, whose French has degenerated into a Creole patois so corrupt that it can with difficulty be understood by outsiders."

From a scientific point of view, the most important statements made relate to Voudou worship and sacrifice. The author says that the people of Haïti are practically under the control of Papalois or Voudou priests, otherwise Haïtian witch-doctors and medicine-men; and he brings charges against them of murders and human sacrifices which the Government of the Republic appears unable to prevent. As to the ceremonies connected with the worship of Voudou, he remarks: "There are said to be two sects of Vaudoux: one which sacrifices only fruits, white cocks and white goats to the serpent-god; the other, that sinister cult above referred to, whose lesser ceremonies call for the blood of a black goat, but whose advanced orgies cannot be fully carried out without the sacrifice of the goat without horns—the human child." Miss Kingsley touched upon this subject in her "West African Studies."

Mr. Prichard made a special point while in Haïti of obtaining information as to Voudou ceremonies and sacrifices, and in some cases was able to obtain direct knowledge. He gives an account of personal observations of some of the rites, which should be of interest to ethnologists.

Untersuchungen zur Blutgerinnung. By Dr. Ernst Schwalbe. Pp. 89. (Brunswick: Vieweg, 1900.)

DR. ERNST SCHWALBE herein summarises the previous researches on the chemistry and morphology of the coagulation of the blood, and adds some new observations of his own.

He has employed Reye's method of separating

fibrinogen from blood plasma by fractional precipitation with ammonium sulphate, and has studied the characters of the soluble fibrino-globulin of Hammarsten, which is present in solution after the fibrinogen solution has been clotted or coagulated by heat. He finds that fibrinogen is not filtered by pressure through a Chamberlain filter, while the other proteids of plasma, including fibrino-globulin, are driven through. He has also determined the heat coagulation temperature of fibrino-globulin.

Dr. Schwalbe has studied the clotting of freshly drawn blood, the blood being suspended in microscopical sections of elder-pith and protected from drying or contact with the cover glass. He concludes that blood platelets arise by the breaking down of red corpuscles, and that agents, such as calcium salts, which promote clotting do so by accelerating the breaking down of the red corpuscles. The original observations are scarcely of sufficient importance to warrant their publication in the form of a separate monograph.

A Manual of Elementary Science. A course of work in Physics, Chemistry and Astronomy, for Queen's scholarship candidates. By R. A. Gregory, F.R.A.S., and A. T. Simmons, B.Sc. Pp. viii+429. (London: Macmillan and Co., Ltd., 1901.) Price 3*s*. 6d.

OF the three parts into which this book is divided, those dealing with physics and chemistry are along familiar lines, but it may be stated that they are treated with the thoroughness and attention to practical details which the authors have accustomed us to expect. It is to the third part that teachers will turn with the greatest interest, for the reason that an effort is made to extend laboratory methods in the teaching of astronomy. Hitherto, with the possible exception of two American books, there has been no guide to this class of work suitable for elementary students who can only give a comparatively small amount of time to the subject. The practical exercises described comprise the illustration of astronomical phenomena by the use of simple apparatus; suggestions for observations of the heavenly bodies themselves, including measurements of altitude, &c., with home-made instruments; the graphical representation of the paths of the sun, moon and planets with the aid of an almanac; and easy numerical exercises. Those who have endeavoured to teach chiefly by the observation of the heavens will appreciate the provision made for instructive work when outdoor observation is not possible or convenient. The course laid down is certainly a step in the right direction, but it would be too much to say that it could not be improved. The use of the globes, for instance, might have been introduced with advantage.

It may be noted that Achernar, by some slip, has been wrongly included in the list of bright stars visible in England (p. 328).

The book throughout is admirably illustrated, many of the diagrams being original. A number of useful exercises are appended to each chapter.

The Mind of the Century. By various authors. Pp. 141. (London: T. Fisher Unwin, no date.) 2*s*.

THE essays in this volume are characteristic aspects of progress during the nineteenth century, seen from sixteen different points of view; they originally appeared in the *Daily Chronicle*, and it may perhaps be doubted whether any useful purpose is served by reprinting them. A glance at the lines of intellectual development may be sufficient for a daily newspaper, but it is scarcely accurate to describe a very general view as a representation of "The Mind of the Century." It will be sufficient to say that Prof. Tilden's article on chemistry occupies five pages, and he would probably be the first to disclaim any desire to have it regarded as more than a very slight sketch of a few lines of progress. Dr. H. J. Campbell writes on medicine, Mr. Edward Clodd on natural science (in which he includes astronomy), and Mr. W. A. Price on applied science, the whole of the articles on scientific subjects occupying thirty-three pages. To what extent the minds of men of science—both pure and applied—can be faithfully reflected within these limits we leave our readers to judge. The book has no index.

Morison's Chronicle of the Year's News of 1900. Compiled by G. Eyre-Todd. Pp. 446. (Glasgow: Morison Brothers, 1901.) 3*s*. 6*d*. net.

THIS is a diary of events and news of the year 1900, and it may be taken as a convenient index to the subjects which occupied public attention in the newspaper press during that year. It is in no sense a record of scientific thought and work, and the compiler has apparently made no attempt to form an accurate estimate of the relative standing of learned societies, or to apportion space according to the value of their proceedings.

In the index, under societies, we notice the Royal Society of Edinburgh (the reference being to a single meeting in 1900), but not the Royal Society of London; a meeting of the Scottish Meteorological Society is recorded, but none of the Royal Meteorological Society; the Society of Chemical Industry appears, but not the Chemical Society, or the Physical, or the Astronomical, or the Linnean, Zoological and many others. So far as science is concerned, therefore, a reader of the diary would prevent himself from being disappointed if he assumed that the volume took no account of the scientific news of 1900. We must, however, be charitable, for, after all, the news and events recorded in the volume are, to the general public, of more interest and value than many contributions to natural knowledge.

Imitation, or the Mimetic Force in Nature and Human Nature. By Richard Steel. Pp. xii+197. (London: Simpkin, Marshall and Co., Ltd., 1900.)

THE canon of affirmative reasoning, which may be said to form the text of this book, is expressed by the author as follows:—"That which is true of a thing is probably true of its like; the degree of probability depending upon the extent and thoroughness of the resemblance." This principle is applied to the reasoning employed in connection with such subjects as habit and instinct, psychology, physics and biology, and other branches of intellectual inquiry in the natural and spiritual worlds. It is the expression of the theory of imitation, which the author propounds "as a fundamental influence in human affairs and in the natural universe generally." Many general facts of natural history lend themselves easily to this idea, and use is made of them. How the author does this, and shows that even wave motion is "essentially mimetic or imitative," can be better read than described.

In Nature's Workshop. By Grant Allen. With 100 illustrations by Frederick Enock. Pp. 240. (London: George Newnes, Ltd., 1901.) Price 3*s*. 6*d*.

IN reading this book one cannot fail to notice a considerable resemblance between Mr. Grant Allen's manner of treating his subject and that adopted by the late Dr. Taylor in his "Sagacity and Morality of Plants." But while the latter work consisted only of examples taken from the vegetable kingdom, here the animal kingdom, and especially the insect world, receives a large share of attention. Thus there are chapters on "sextons and scavengers," dealing with burying beetles; "false pretences" and "masquerades and disguises," dealing with warning colours, mimicry and such matters; "animal and vegetable hedgehogs," dealing with spiny fishes, insects, cactuses, lizards and beetles; "plants that go to sleep." The book should prove delightful reading to young people and others who can take an interest in natural history treated in an unscientific and popular

way, and Mr. Enock's skill as an artist in portraying all sorts and conditions of animal and plant life greatly add to its charm.

Elementary Organic Analysis. By F. G. Benedict, Ph.D. Pp. vi+86. (Easton, Pa.: The Chemical Publishing Co., 1900.) Price 1 dollar.

DR. BENEDICT describes processes for the determination of carbon and hydrogen in organic analysis. His manual is distinguished by completeness of detail concerning the setting up and manipulation of the analytical apparatus, and the treatment necessary for various classes of compounds. The book should be of service in directing students how to carry out organic combustions satisfactorily.

Elevation and Stadic Tables. By A. P. Davis. Pp. 42. (New York: J. Wiley and Sons. London: Chapman and Hall, 1901.)

HYDRAULIC tables showing velocities for various channels and slopes are given in this volume, as well as tables "for obtaining differences of altitude for all angles and distances, horizontal distances in stadic work, &c., with all necessary corrections." The book has been prepared and published because there is a need for such a handy manual in the field work of surveying and in practical problems connected with canal construction. As such its usefulness is assured.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Recent "Blood Rains."

THE quantity of dust carried over to Europe by winds from the African Continent during the present month seems to have been unusually great, for traces of the "blood-rain" are said to have been noticed as far north as Hamburg and Schleswig-Holstein, while, in most cases, such phenomena are confined to the countries immediately bordering the Mediterranean. My colleague, Prof. A. W. Rücker, who has been staying at Taormina, in Sicily, has forwarded to me some very interesting observations which he has made on the subject. Writing on March 12, he says: "We have had a rather curious phenomenon here. The sirocco was blowing, and the hills were wrapt in mist, but the fog assumed a yellow hue, and the sun, which at times could be seen through it, was a bright blue. This was caused and accompanied by a copious fall of red dust. Some which I shook off my hat was quite dry, and on looking at it through a low-power lens all the granules seemed to be spherical, except a very few grains of what looked like quartz. Of course, the question was raised whether Etna was ejecting something which corresponded to the Krakatoa dust, but this was negatived by the fact that the Italian papers state that the dust fell also at Naples and Palermo in such quantity that the streets looked red and the people were frightened. I scraped some off a marble table which I send you."

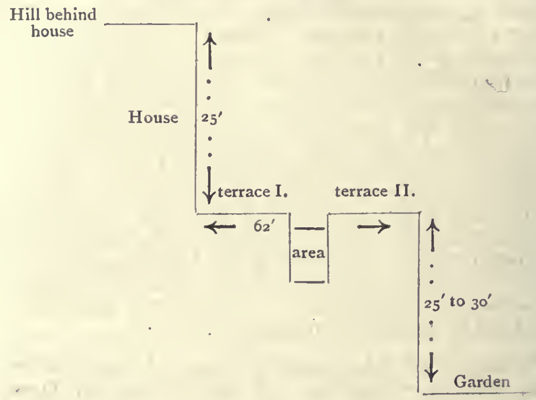
Under the microscope this dust is seen to be mainly composed of inorganic particles, chips of quartz in small quantities being mingled with minute plates of various micaceous and other minerals. There is also a fair admixture of frustules of freshwater diatomaceæ, entire and in fragments. The number and variety of these diatomaceæ does not appear to be so striking as in some of the celebrated cases described by Ehrenberg, the organisms from which were figured by him in his "Passat Staub und Blut Regen" (1847). There are, however, a very considerable number of species represented in these recent falls.

Vague statements have appeared in some of the newspapers as to the number of millions of tons of dust which, during the present month, have fallen over Italy. The data upon which these statements have been made have not been given, so that the following memorandum on the subject, drawn up by Prof. Rücker, cannot fail to be of interest to readers of NATURE.

Royal College of Science. J. W. JUDD.

March 20, 1901. *Taormina, Sicily.*

"At 7.30 this morning the sky was copper-coloured, and it was evident that another fall of dust was taking place. The sirocco had been blowing for two days, and it was raining slightly.



The general outline of the hotel is as shown. The two terraces are connected by a bridge. On the terraces were several rectangular marble tables, and it occurred to me that it might be interesting to find the amount of dust on some of them.

It is, of course, possible that the rain may have washed some of the dust off them, but I looked at the terrace when dry and saw no signs of a specially great aggregation of dust under the tables.

The aspect of the terrace is about S.W., so that the house did not shelter the tables, as the wind was blowing towards it; but, of course, eddies may have had an effect.

The sky ceased to be copper-coloured about 8 or 8.15, and I have no reason to suppose that any large quantity of dust fell while the experiments were being made.

Table I. Was on the western half of the inner terrace I., about 13' from the house. It measured $24\frac{1}{2}'' \times 46'' = 1127$ square inches. The mingled dust and water were scraped off with the edge of a sheet of paper into the cover of a biscuit box, then dried over a spiritine (alcohol) flame. The dust adhered rather strongly to the box, and had to be scraped off with a knife, which removed some shavings of the tinning.

Collection made at 9 a.m.

Table II. Further east, on terrace I., near a point where the level of the house fell to about 17'. Distance from house, 13'. Dimension, $22\frac{1}{4}'' \times 40\frac{1}{2}''$, or, say, 900 square inches. Collected as before but into two plates, one earthenware, and the other enamelled iron. The dust had to be scraped off, but I do not think the knife removed anything from the plates.

Collection made at 10.15 a.m.

Table III. This was the best experiment. The table was on the outer terrace, 58' from the house, and close to the edge of the terrace. Area, $24\frac{1}{4}'' \times 46\frac{1}{2}'' = 1127\cdot5$ square inches. The scrapers used were rags of clean muslin, which were afterwards washed in water to get as much dust as possible out of them, and the quantity so obtained (which was small) was added to the rest. The dust and water were put in a clean bottle and preserved. No drying was done in this case.

Collection made 10.45.

In the afternoon I borrowed a balance from a photographer. The smallest weight was a gram, but the balance would turn to less, and I made smaller weights by cutting a piece of stout paper to such a length that it weighed a gram, measured its length and cut off measured lengths from it. I weighed in both pans and found there was no important difference. The whole experiment was rough, but the amounts deposited on the two tables appear to have been so different that great accuracy in weighing is not important.

Table I. Weight of dust, 1·13 grams.
Area, 1127 square inches, or, say,
0·0010 gram per square inch.
Table II. Weight of dust, 1·54 grams.
Area, 900 square inches, or, say,
0·0017 gram per square inch.
Table III. Preserved wet, and therefore not weighed.

The difference between the results is too great to be accounted for by differences in care in scraping or errors of the weighings. It is either due to the fact that more dust had been carried off one table by the rain than off the other, or it shows that near the house the distribution was uneven. Still, the mean of the two gives an idea of the order of the density on the inner terrace, which was about 0·00135 gram per square inch, or, taking 25 mm. = 1 inch, 2·2 grams per square metre, or about $5\frac{1}{2}$ tons per square mile, though, of course, to argue as to the average fall over so large an area as a square mile is a big extrapolation.

Note upon a New Form of Spermatophore in an Earthworm.

IT is well known that the Oligochæta (like many other animals such as molluscs, insects, &c.) form spermatophores. Up to the present time two types of these spermatophores have been recognised in the Oligochæta. In the Lumbricidæ, *Criodrilus*, &c., they are compact cases, generally open at one end, and found invariably attached to the outside of the body in the neighbourhood of the reproductive orifices; they are sometimes even slightly imbedded in the skin. The other type of spermatophore characterises *Tubifex* and several allied genera, as well as the Eudrilid earthworm, *Polytoreutus*. These are long thin motile bodies. They are found only in the spermathecæ of those Annelids which they characterise. I have lately studied the structure of a third variety of spermatophore which I found in the spermathecal sac of another Eudrilid genus, *Stuhlmannia*. This worm is long and slender, not measuring more than 2 mm. in diameter. The spermathecal sac in which the spermatophores are found is about 7 or 8 mm. long. I never found more than two of the spermatophores in a sac; they measure some 3 mm. in length. The shape is peculiar. There is a "head" very similar to that of the spermatophore of *Tubifex*, a long "beak," open at the extremity, is followed by a circumferential swelling, which is again succeeded by a narrow neck; this in its turn gradually widens until at the middle the spermatophore is large and plump. The interior was a mass of separate spermatozoa entirely uncompacted together. The site of the formation of the spermatophores has been much disputed. It seems to be clear, from the investigations of Mr. Lankester, that in *Tubifex* they are at least moulded in the spermatheca, since the collar of the head of the spermatophore not only corresponded in form with certain foldings of the spermathecal wall, but was actually observed lying *in situ*. As to the origin of the material, Mr. Lankester and Prof. Vejdovsky were disposed to trace it, partly at least, to the "cement gland" of the male efferent apparatus. I find in *Stuhlmannia* that the moulding of the head of the spermatophore must be accomplished in the spermathecal sac, since I also observed a spermatophore lying *in situ* with its convexities fitting into corresponding concavities of the walls of that sac. Further, the large size of the spermatophore necessitates the hypothesis that the whole of it is moulded in the sac, since it could not possibly be contained—even with the greatest stretching—in the spermiducal gland. As to the origin of the material of the case, I hold it to be proved that part comes from the spermiducal gland and that the rest is, in all probability, a result of the breaking down of the abundant cells which line the spermathecal sac. I may add that no spermatozoa protrude through the case. This spermatophore of *Stuhlmannia* is evidently somewhat intermediate in its characters between the two types already known.

FRANK E. BEDDARD.

Graphic Solutions of the Cubics and the Quartics.

THE note by Prof. G. B. Mathews, F.R.S., published in NATURE of November 16, 1899, has encouraged me to write the following, which may be also of some interest. I have considered not only the quartics, but also the cubics. For the quartics, the methods in this letter will be simpler than those of Prof. Mathews. We require to have a sheet of squared paper on which the curve $y=x^3$ for the cubic and the curve $y=x^2+x^4$ for the quartic have been printed.

I. For the cubic, take the curve $y=x^3$ and a straight line the equation of which is $\frac{x}{a}+\frac{y}{1}=1$. Then the abscissæ of the intersections of the curve and the straight line are the real roots of $x^3 + \quad - 1=0$. Now the general cubic is at once reducible to the form $z^3+pz+q=0$, and if we put $z=-x\sqrt[3]{q}$, this becomes $x^3+\frac{p}{q^{\frac{2}{3}}}x-1=0$. This is identical with the former if $a=\frac{q^{\frac{2}{3}}}{p}$; so we can calculate a very easily, then read off the real values of x, and finally take $z=-x\sqrt[3]{q}$.

II. For the quartic, take the curve $y=x^2+x^4$ and a straight line the equation of which is $\frac{x}{a}+\frac{y}{b}=1$. Then the abscissæ of the intersections of the curve and the straight line are the real roots of $x^4+x^2+\frac{b}{a}x-b=0$. Now the general quartic is at once reducible to the form $z^4+pz^2+qz+r=0$, and if we put $z=x\sqrt{p}$, this becomes $x^4+x^2+\frac{q}{p^{\frac{3}{2}}}x+\frac{r}{p^2}=0$. This is identical with the former if $a=-\frac{r}{q\sqrt{p}}$, $b=-\frac{r}{p^2}$; so we can calculate a and b very easily, then read off the real values of x, and finally take $z=x\sqrt{p}$.

For the quartic, we can take also the parabola $y=x^2$ and a circle $(x-a)^2+y^2=\rho^2$.

T. HAYASHI.

Matsuyama Chūgakkō, Iyo, Japan, December 28, 1900.

"The Principles of Magnetism and Electricity."

THERE are two points occurring in the review (p. 434) of "The Principles of Magnetism and Electricity" in which the author appears to me to be correct, though the examples are given as instancing errors into which he has fallen. The reviewer states, "The author measures magnetic force in *dynes* and difference of potential in *ergs*," thereby apparently implying that this is incorrect. Surely these are usual units for expressing these quantities. Again, the author is taken to task for stating that in the case of a dynamo or motor armature, "owing to the self-induction of each section, a certain amount of energy is used twice in each revolution to establish the current in it. *This energy is lost* so far as the external circuit or the effective output of the machine is concerned." Whilst with a dynamo running sparklessly with copper brushes this is only partially true, the difficulty of obtaining the return of the energy thus absorbed is in practice so great that we see on a very large proportion of machines that carbon brushes are used, the object of which is to enable this energy to be wasted without an actual spark, and it is well known that machines with carbon brushes thus working have a higher rise of temperature from the waste of power than when true electrodynamic commutation takes place. Actual measurements of power absorbed have also shown a waste of power from this cause sometimes exceeding 5 per cent. of the output of the machine.

London, March 12. LLEWELYN B. ATKINSON.

THROUGH the courtesy of the Editor I am able to reply to the letter of Mr. Llewelyn B. Atkinson, in which he challenges two of my criticisms in the review of "The Principles of Magnetism and Electricity," by Mr. P. L. Gray. Mr. Atkinson states that I "apparently imply" that measuring magnetic force in *dynes*, and difference of potential in *ergs*, is incorrect. To prevent any misconception, I now wish to state quite definitely that I regard the above method of measurement as hopelessly and absolutely wrong. If it be correct, then magnetic force is a quantity whose dimensions are identical with those of dynamical force, and difference of potential a quantity of the dimensions of energy. If Mr. Atkinson is satisfied with these conclusions, and is prepared to uphold them, I have no further remarks to offer on the subject. I may, however, point out that measuring difference of potential in ergs is about as logical a proceeding as measuring difference of (gravitational) level in ft.-lbs. Some eccentric people might, no doubt, be found to uphold this latter proceeding. But a falsehood does not become a truth merely because a number of people give their unreasoning assent to it.

With regard to the second criticism, that relating to the process of commutation in a dynamo, I still maintain that the statement in Mr. P. L. Gray's book is misleading and incorrect in its generality, and Mr. Atkinson practically admits as much in his letter. Nothing is said by Mr. Gray as to the particular statement in question being intended to apply to carbon brushes under certain conditions of use. It is a general statement, made without any qualifications, and as such is incorrect.

THE REVIEWER.

THE LAND WORK OF THE BELGIAN ANTARCTIC EXPEDITION.

At the present moment the Antarctic problem is mainly that of the forthcoming expeditions, and during their preparation every fact bearing upon the conditions, physical and official, in which the scientific staffs will have to work has a special interest. So far the Belgian expedition has yielded most information of a useful kind, and the two latest papers of its enthusiastic geologist, M. Henryk Arçtowski, are of more than usual value.[1] The general account of the expedition contains nothing that will be new to our readers. M. Arçtowski concludes it by the observation that while the scientific results have been varied and satisfactory, the chief outcome is that the great public has been acquainted with the paucity of our knowledge of the Antarctic area, and shown how trifling is the work accomplished compared with that which remains to be done.

The paper in the *Geographical Journal* is the most detailed and valuable description of land on the confines of the Antarctic region that has ever been published. It records, in the form of a narrative from day to day, the exploration of Belgica Strait, the new channel discovered by the expedition, separating the Palmer Archipelago from the mass of Graham Land with which those islands were formerly supposed to be continuous.

The twenty landings which the importunity of M. Arçtowski induced the reluctant commander to permit are described in detail; but, as none of the new names given by the expedition are employed, and practically no other names exist in that region, it is impossible to follow the description without reference to the sketch map on which the landings are marked. This is accordingly reproduced as Fig. 1.

The opportunities of landing were numerous, but the time allowed on shore was usually absurdly inadequate to the importance of the work of surveying and geological investigation. In the only case where a week was spent on shore practically nothing was done because of the unnecessarily heavy equipment insisted on by the commander—a sailor of no scientific qualifications, and apparently devoid of sympathy with the more important objects of the expedition. Still, it must be remembered that but for de Gerlache's burning ambition to reach a high southern latitude (an ambition which was not gratified) the expedition would never have been dispatched, and no scientific work of any kind would have been done. The following paragraphs are a much-abridged summary of M. Arçtowski's narrative.

At 7 p.m. on January 23, 1898, having passed the South Shetlands, the *Belgica* was close to a headland, which probably was Cape Cockburn, but as she went on the charts became valueless. What was seen corresponded to nothing that they represented, and Lecointe proceeded to construct a fresh chart from his own surveys. At 10.30 p.m. the first landing was made on an island in Hughes Bay (see I. on map, Fig. 1). A considerable part of the island was uncovered. The upper part was like a lava-flow of prismatic structure. Lower down the rock was completely cracked, and seemed to decompose in large superimposed blocks with straight surfaces. It was an eruptive rock of great density, very hard and brittle, and ringing on a blow with the hammer. It was not basaltic, but of granitic structure and very fine-grained; its colour was a very deep green, and M. Arçtowski thought that he saw small crystals of hornblende; if so, the rock would be a diorite.

On January 24 the second landing was made (II. on map, Fig. 1) on a small narrow island, no more than 100 feet high and almost free from snow; it appeared to be surrounded by a close colonnade, on account of the regular vertical cracks in the rock, which were doubtless produced by extreme cold. The surface was frequently mammilated and worn smooth by the ice. Here, M. Arçtowski says, "A little sandy clay mixed with guano was found in small pockets between the rocks, and while examining this I had the pleasure of discovering the first Antarctic insect, almost microscopic in its dimensions." The general result of that day's nautical work had been the discovery of an elevated land where Friederichsen's map bore the inscription, "No land in sight (Larsen)." Towards the east and south an uninterrupted coast-line stretched as far as the eye could

FIG. 1.—The track of the Belgian Antarctic Expedition in Belgica Strait. From the *Geographical Journal.*

[1] "L'Expédition Antarctique belge," *Revue Générale des Sciences*, 12 (1901), 87–94. "Exploration of Antarctic Lands," *Geographical Journal*, 17 (1901), 150–180.

reach, but in the south-west a large strait opened into Hughes Bay, and this it was necessary to explore. The quantity of snow on the land was found to be formidable. The westerly and northerly winds coming from the ocean doubtless brought great falls of snow, and this was always accumulating, mountains of ice were reared on the top of the mountains of rock. So far as could be judged from the ship, the ice was nowhere uncovered, but thick snow seemed to lie on the glaciers down to the very edge of the sea.

About midnight a landing was made in a little bay (III. on map, Fig. 1), where a ground moraine, or something closely resembling one, was found. There was water behind it and then a cliff of ice, the end of a great glacier which covered the whole slope of the mountain. Although it was growing very dark and the specimens were collected hurriedly, more than ten different varieties of rocks were obtained, none, however, of sedimentary formation.

The next landing was for three hours, on the 25th, in lat. 64° 6′ 24″ S., long. 61° 59′ 30″ W., on the promontory of an island (IV. on map, Fig. 1), and it was not without difficulty that all the delicate instruments were got ashore on the steep rocks. "Cook and I," says M. Arçtowski, "made use of Canadian snow-shoes to visit the higher part of the island, and found them a great aid in crossing the snowy slopes, which were usually gentle, though there were dangerous crevasses in places. A thick mantle of snow stretched to the crest of the promontory and stopped abruptly, the further side being perpendicular. . . . It was a region quite alpine in its character, but completely buried, in glaciers. The snow-fields rose towards the interior forming a veritable ice-cap, terminating in a perfectly continuous sky-line. . . . Lower down the relief of the land could be divined beneath its robe of snow, and here and there a bare peak pierced the covering. Nothing like an exposed chain of mountains was to be detected, although near the sea a coast range could be made out, its sides cut by valleys through which glaciers of various sizes made their way. Along the shore some of the promontories were bare, but on the lower ground the ends of the glaciers were covered by a field of snow, and were for the most part confluent, forming a plateau of ice which gave origin to icebergs. That valleys exist, though they do not show on the surface, is clear from the differences in the size and appearance of the glaciers. The largest are of gentle slope, the smaller steep and broken by numerous crevasses. Some of the glaciers suspended from the cliffs were of extraordinary dimensions. Thus by the appearance of the surface of the ice, without any other evidence, one could see that the configuration of the buried land was complicated, and underneath each glacier there must be a great excavated valley, along the bed of which the ice glides downward. The existence of valleys is very interesting, for it points to a time when there was no ice, but dry land being eroded by the running water of rivers. On the other hand, the thought of these buried valleys brought to my mind the channels of Tierra del Fuego as they must have appeared in the glacial period, when the end of the Andean chain lay under just such an ice-sheet."

In the afternoon of Wednesday, January 26, Cook, Amundsen and Arçtowski landed on Two Hummocks Island (VI. on map, Fig. 1), which was narrow and entirely covered with a thick mantle of snow, giving it a convex appearance. Two pyramidal mountains projected like nunataks, contrasting with the general smooth outline. The party landed on the north coast in the hope of being able to climb one of the mountains, and found that the shore was formed by a cliff of ice, with only a few promontories of bare rock. The ice was not found to be actually immersed in the water at any point; a very narrow strip of bare rock always separated it from the sea. A little snow rested even on the *roches moutonnées*, which bordered the shore, either awash or rarely rising so much as a yard or two above the surface, and the sea-leopards were sleeping upon them very tranquilly. The rock of the island was a grey granite, with thick and very regular veins of a dark and compact green rock, and also smaller red veins. There were some erratics, which might have been carried by floating ice.

At 2 p.m. on the 28th an island was visited which showed an appearance of stratification (VIII. on map, Fig. 1), but the whole surface was found to be a smoothly glaciated rock of eruptive origin, traversed by grey compact veins twenty feet thick.

On Saturday, January 29, the weather was calm; the fog had cleared away and revealed a marvellous scene. On every side the thick white covering descended to the sea, and only the most abrupt slopes were free from snow; perpendicular cliffs and steep hillsides were characteristic of all these coasts. A cliff which bordered a submerged valley where an immense glacier debouched showed an appearance of vertical stratification, but the ninth landing sufficed to prove that this appearance was due merely to cracks in the rock, as in all previous cases. This may possibly be an effect of extreme cold, for the *roches moutonnées*, which are preserved from rapid changes of temperature by a covering of snow during most of the year, do not exhibit such cracks, or only to a slight extent.

The only attempt at a land journey must be described in the author's own words. It commenced on Sunday, January 30. "The commandant decided to accompany the land-party, . . . but the preparations which had to be made were too elaborate, and the projected excursion was doomed to failure before it set out. In order to succeed, it would have been necessary to carry all the absolute necessaries on our backs and make a great and sustained effort, being prepared, if the route was bad, to return and choose a better way. . . . We took with us two sledges of Nansen's pattern, sleeping bags, a silk shelter tent, a little aluminium stove, such as was used by Jackson, Norwegian *ski*, Canadian snow-shoes, ice-axes, a 40-foot rope of raw silk, provisions for a fortnight, even changes of underclothing, and all the instruments after that. Certainly far too much baggage. . . . We landed on a little promontory at the head of a fine bay, where a large glacier entered the sea and the snow lay down to the water's edge (X. on map, Fig. 2[1]). There was no difficulty in getting ashore, but the sledges were horribly heavy. . . . At a height between 400 and 600 feet we had to cross several crevasses, which were narrow and spanned by snow-bridges solid enough to allow our loads to pass without difficulty. Higher up a great snow-field stretched before us, whence we could look down upon the glacier which cascaded towards the bay. . . . At 2.30 p.m. during lunch I placed the black-bulb thermometers on the snow, and, although the sun was slightly veiled, they showed readings of 102°·6 and 86° Fahr., while the temperature of the air, measured by a sling thermometer, was only 34°·2. The strength of the solar radiation made us all feel very warm. We enjoyed an extensive view towards the south, and saw the high mountains on the opposite side of the strait diminishing gradually in height towards the east; the direction of the chain seemed to be north-east and south-west. . . . At 7 p.m. we were still mounting upwards, the weather being remarkably good, and the view of Graham Land grew finer and finer. The relief of that land, although excessively varied, is singularly softened by the glaciers and the accumulated snow, so that it can only be because the valleys, hollowed by the running water of some former epoch, are so deep that a few crests and very abrupt slopes remain bare. At the height of 1600 feet

[1] Fig. 1. in this article.

we were stopped by a crevasse more than thirty feet wide, which we could not cross, and other crevasses appeared beyond it, the whole glacier having a terraced structure. . . . All Tuesday we were dragging our loads uselessly towards a hill in the west, but in that direction also we were stopped by numerous crevasses. . . . Again we had to retrace our steps to the ice-plain to pass the night, and there we left our camp for the two following days, seeing that it was impossible to reach any high summit. . . . From the summit of the more distant nunatak, Cook and I had a good view of the *mer de glace* in which the large glacier terminated at the head of the bay where we landed. Although the broken fragments could not give rise to icebergs as they entered the water, it seemed quite possible that in winter, when the bay is frozen, enough ice might accumulate to form one or more bergs. In any case, it appeared certain to me that the bottom of this great valley extended below the level of the sea; and I was also led to believe, judging from the distances which separated the nunataks and the angle of slope of the walls, that the same held good for the valley in which we camped. We found some lichens and mosses on the nunataks."

On Sunday, February 6, the party got on board the *Belgica*, and steered towards the east, in order to continue the survey of the coast of Graham Land. The air-temperature was high all that day, with a maximum of 45° F. At night it rained, at times very heavily, and it must have produced a great effect upon the snow-fields, a much greater effect, probably, than a day of strong sunshine.

The party succeeded in landing on February 7 at the base of a granitic cliff, near which, upon a little promontory, a metamorphic schist was discovered in contact with the granite (XIII. on map, Fig. 1). The direction of the strata was north-west and south-east, and their dip towards the north was about 45°; a very friable schist alternated with a dark quartzite, and dark green strata of a highly metamorphosed rock.

The fourteenth landing (XIV. on map, Fig. 1) was on a large island. M. Arçtowski thus describes it: "I saw a channel which separates it in the south-west from another land; and to the north-west the sea-horizon was unbroken—it was the Pacific Ocean. I saw this confirmation of my theories[1] with much pleasure; there was no doubt that we were on the west coast of the continental land symmetrically placed with regard to the Southern Andes. There is no passage to the east, and the Biscoe Islands form a parallel chain belonging to the mountain system of Graham Land. . . . We remained some time on the strip of bare rock which was exposed between the field of névé and the sea. It was the same black granitoid rock traversed by thick veins and narrow threads of quartz; and there was a great variety of erratic blocks, including specimens of basalt, breccia, several blocks of conglomerate, and some fragments of quartzite. A cave was found in the large-grained porous ice-wall, along the uncovered bed of which a little stream flowed, the first glacier stream I had seen. It came from the direction of a nunatak, and consequently could not have pursued its course from a long distance under the ice; in its bed there were rolled pebbles of eruptive rocks."

On Wednesday, February 9, at 7.30 a.m., the fifteenth landing was made (XV. on map, Fig. 1). The whole coast appeared like one great *roche moutonnée* entirely free from snow, everywhere smoothly polished and scored with sharp grooves, often very deep, running in all directions and crossing each other. The larger were vacant, but others were filled with thin leaves of rock, and some with compact grey veins giving the rock a schistose appearance. The surface of the granite was strewn with splinters split off by the effects of radiation, usually from one-third to two-thirds of an inch thick, and about a foot in diameter. There were no erratic blocks. The rocks were bare up to a height of about 150 feet, but from this level snow uniformly covered the island and gave rise to a trickle of water, forming cascades, under which an abundant vegetation of mosses and algæ had accumulated. A few tufts of moss were found here and there among the stones. The sun shone strongly, and the bare rock grew quite warm. At 8 a.m. on the *Belgica*, when the air temperature was 41° F., the black-bulb thermometer in the sun read 87°·8, hence the splintering of the surface of the rocks could easily be understood. At 10.30 the *Belgica* passed the cape at the south end of the mountainous island, and the recording thermometer fell, while the hygrometer rose sharply as the influence of the ocean made itself felt; and in the distance great icebergs could be seen in the open Pacific. At 11 o'clock the sixteenth landing was made on one of a group of twelve small low islands (XVI. on map, Fig. 1). Lecointe landed for the noon observation of the sun, making use, as before, of an artificial horizon; Arçtowski, Racovitza, Cook and Danco accompanied him. The whole islet was covered with moist snow almost to the water's edge; a remarkable difference in the height of the snow-line being observable in the short distance separating the fifteenth and sixteenth landings. All the islets of the neighbourhood had the same appearance, like great whale-backs rising from the sea. The polished rock extended to just below the surface of the water, and there were also several glaciated rocks scarcely emergent. The whole group seems to form a plateau which has been profoundly glaciated, and of which only the higher portions now appear; but this plateau has nothing, in M. Arçtowski's opinion, in common with the continental shelf, the whole of the district presenting clear evidence of being a submerged region. From another point of view, these islands are by no means to be considered as the stumps of mountains worn down by marine erosion; they afford evidence of a great extension of glaciers in some bygone period. The whole of Belgica Strait had probably at one time been filled by a great glacier which flowed to the Pacific. The cutting off of the summits of these islands may be its work.

At noon on February 10 the eighteenth landing was made, almost opposite the seventeenth, on the other side of the large channel (XVIII. on map, Fig. 1). It was at the base of a pyramidal mountain of red rock, very different in appearance from the surrounding scenery. A great band of red granite seemed to traverse the region from north-north-west to south-south-east. The interesting feature of this landing was the discovery of a moraine, at least 70 feet in height, which was set against the mountain-side along part of the beach in the direction of the channel. The rock itself was highly glaciated to just below the level of the water. Here we must once again give the author's own words: "The commandant showed himself very obliging, but with a little goodwill we could have landed in many other places and collected much more geological material than we did. For this eighteenth landing he conducted me himself, but for ten minutes only. A few strokes of the oars brought us to the beach, amid cries of "Hurry up, Arçtowski!" I gave a hammer to Tellefsen, with orders to chip here and there down by the shore, while I hurriedly climbed the moraine, picking up specimens as I ran, took the direction with my compass, glanced to the left and right, and hurried down again full speed to get a look at the rock *in situ*; meanwhile Cook had taken a photograph of the place from the ship—and that is the way geological surveys had to be carried out in the Antarctic."

At ten a.m. on February 11 the twentieth and last landing was made on the Pacific slope of the Needles,

[1] *Bull. Soc. Géol. France*, 1895, p. 590

which form the northern cape of Graham Land (XX. on map, Fig. 1. and view Fig. 2). In places the beach was quite free from snow, elsewhere there were small glaciers clinging to the slopes of the mountain and terminating seawards in cliffs of ice. The steep rocky slopes above were absolutely bare up to a height of 700 or 1000 feet, and beyond that rose fields of névé. Two of the party climbed a little ridge running at right-angles to the range of the Needles. An inclined plane of snow, interrupted here and there in the upper part by transverse crevasses easy to cross, led them to the rocky wall, which there was no difficulty in climbing, thanks to the numerous joints widened by weathering so as to cut up the face of the rock into superimposed blocks, and thanks also to the narrow chimneys down which the débris of the rock slipped. It is remarkable that these rocks remained quite bare at an elevation far above the snow-line. It is not sufficiently accounted for by the steepness of the slope, though that would make it possible for only a small quantity of snow to accumulate; but the dark walls were so strongly heated by the sun that the snow was actually melted. In making the ascent it was found that the low cloud, characteristic of these regions, was very thin and level on both the lower and upper surfaces, the belt of mist having been passed through between the altitudes of 150 and 300 feet, and above that there was an absolutely clear sky and dazzling sunshine, while the cloud extended as a smooth grey sea underneath. If such a condition often occurs, it is easy to see how the higher rocks become free of snow in summer, while those near sea-level remain covered.

After this landing the *Belgica* entered the Pacific, turned southwards into the ice-pack, and for a year drifted hither and thither, fast in the ice out of sight of land.

FIG. 2.—The Needles seen from the Pacific. From the *Geographical Journal*.

THE INTERNATIONAL ASSOCIATION OF ACADEMIES.

AN account by M. Gaston Darboux, permanent secretary of the Paris Academy of Sciences, of the inception and first meeting at Wiesbaden of this International Association, was given in NATURE for July 12, 1900. To the January number of the *Journal des Savants* M. Darboux contributes a further article on the same subject, in which, after again sketching the events which led to the rise of the Association, he gives an account of the Paris meeting and the arrangements for future work.

In this interesting article it is explained that the Royal Society and the Paris Academy took the initiative in the formation of this important Association, the advantages of which were pointed out by Lord Lister, as president of the Royal Society, in a letter dated November 17, 1898, addressed to the president of the Academy of Sciences of Paris. Among the questions of the first importance is that of the Catalogue of Scientific Papers, already commenced single-handed by the Royal Society. To carry this out completely it has been estimated that in the domain of the positive sciences alone the annual catalogue should comprise seventeen volumes and about two hundred thousand entries, a task evidently capable of being successfully accomplished only by combined international effort.

The academies and societies represented at the Wiesbaden conference decided to found an International Union of the principal scientific bodies of the whole world under the name of the "International Association of Academies"; the members of this Association being as follows:—

(1) The Royal Prussian Academy of Sciences, at Berlin.
(2) The Royal Society of Sciences, at Göttingen.
(3) The Royal Saxon Society of Sciences, at Leipzig.
(4) The Royal Society, at London.
(5) The Royal Bavarian Academy of Sciences, at Munich.
(6) The Academy of Sciences, at Paris.
(7) The Imperial Academy of Sciences, at St. Petersburg.
(8) The Royal Academy, at Rome.
(9) The Imperial Academy of Sciences, at Vienna.
(10) The National Academy of Sciences, at Washington.

The following academies were also invited to take part:—

(1) The Royal Academy of Sciences, at Amsterdam.
(2) The Royal Belgian Academy of Sciences, Literature and the Fine Arts, at Brussels.
(3) The Hungarian Academy of Sciences, at Budapest.
(4) The Society of Sciences, at Christiania.
(5) The Royal Society of Sciences, at Copenhagen.
(6) The Royal Academy of History, at Madrid.
(7) The Academy of Inscriptions and Literature, at Paris.
(8) The Academy of Moral and Political Sciences, at Stockholm.

Rules were also formulated regulating the admission of new academies, the constitution of the council and committee, the holding of general meetings every three years, and the mode of government during the intervals between the general meetings.

It was decided that the first reunion of the International Association should be held in Paris in July 1900. At this conference, besides formal business dealing with questions of constitution, three propositions brought forward by constituent academies were considered. The Royal Society drew attention to the desirability of connecting the measurements of Struve upon the arc of meridian 30° E. with those of Gill on the same meridian in South Africa; the Academy of Berlin raised the question of the best means of facilitating access to manuscripts and other documents; and on the proposi-

tion of the Paris Academy it was decided to assume control of the committee of physiology, having for its object the standardisation of the self-recording instruments used in physiology and increased uniformity in the methods used in that science.

M. Darboux concludes his article by mentioning a matter which proves at least the interest excited by the formation of the International Association of Academies, namely, that intended donations have already been announced. At the suggestion of M. Diels, it has been decided that any one having expressed the desire to give to the Association the means to develop its action could make the donation, with special instructions, to any of the academies taking part in it. Other less determinate projects will come before the general meeting. One, from the Academy of Munich, has reference to the publication of a "Corpus des actes et diplômes grecs du moyen âge et des temps postérieurs."

Another, suggested by the Academies of Leipzig, Munich and Vienna, is the publication of a "Real-Encyclopædie des Islam."

The committee meeting at Paris had finally to fix the date of the next meeting, the first general meeting. It is to be supposed that some, at least, of the proposals here made known demand careful consideration; hence, to leave the academies which have presented them time to give them a precise and definite form, Tuesday, April 16, which follows Easter Tuesday, 1901, has been fixed as the date of the next general meeting of the Association at Paris.

The various discussions and proposals mentioned are, without doubt, of unequal importance; they have at least the merit of being very varied and of putting in evidence the diversity of the services that may be rendered by the International Association of Academies.

The Association has been received with favour wherever science is cultivated. "Already," remarks M. Darboux, "we look to it for many works which it alone will be capable of realising. It may be recalled that the agreement between scientific men in the field of theoretical research often precedes a good understanding between peoples in the field of practice and business. There is a feeling that a new organism has been created, which should ultimately be called upon to exert a great and beneficent influence. It is important that the constituent academies should justify this feeling and forward the working of the Association by submitting carefully thought out proposals. It is important, also, that all those who expect much from the Association should bear in mind that it has time before it; that, by their very nature, academies are bodies which move with a certain slowness; and that time ought to be given to the new Association to create little by little the means by which it may be able to realise all the hopes to which it has given rise."

PROF. C. F. LÜTKEN.

CHRISTIAN FREDERIK LÜTKEN was born on October 7, 1837, at Sorö, a small town in Zealand, which at that time possessed an academy where his father was professor of philosophy. When quite a young man, even before his student days, his interest in the natural sciences was awakened, and after his examinations were completed he devoted himself heart and soul to zoology. In 1848 his studies were interrupted by the war between Germany and Denmark, in which he enlisted and served as a lieutenant. In 1852 he left the army and obtained his master's degree with distinction, almost immediately after which he was appointed assistant to Prof. Steenstrup, at Copenhagen, whose pupil he had been in his early days at Sorö. Thus began a connection with the zoological museum of the University which lasted for 47 years, terminating only when illness enforced his resignation.

His career was marked by constant devotion to the collections under his charge, and by the publication of a long series of scientific memoirs, published chiefly in the *Transactions* (Skrifter) and *Proceedings* (Oversigt over de Forhandlinger) of the Royal Danish Academy of Sciences, and the *Communications* (Videnskabeliger Meddelelser) of the Natural History Society of Copenhagen. His studies were always intimately connected with his work in the museum, and hence systematic zoology and geographical distribution and, to some extent also, palæontology constituted the main subject of his writings. Almost every one of the larger divisions of the animal kingdom owes something to Lütken's industry, but during his earlier years he concentrated his attention principally on the echinoderms, and later on ichthyology. Under the title "Dyreriget" he published a small text-book of zoology, a work which would have attracted considerable attention had it been in a language more generally understood. It is still the authorised text-book in most of the educational establishments in Denmark. Amongst his scientific writings special attention may be called to three papers on the echinodermata of Greenland and on the geographical and the bathymetrical distribution of northern echinodermata, which constituted the thesis for his doctor's degree; to a memoir entitled "Spolia Atlantica," which gives a large series of important observations on the young stages of many species of fish, and to a communication on *Himantolophus reinhardti*, a deep-sea lophioid fish, in which he first called attention to the probability that the attracting tentacles in these forms are phosphorescent.

On the death of Prof. Reinhardt, in 1883, he was appointed "inspector" of the department of vertebrates, and in 1885 he succeeded Steenstrup as professor of zoology and director of the museum. As a professor he was by no means the conventional pedagogue, and his pupils obtained from his lectures a clear and striking picture of the animal kingdom. Physical weakness, however, gradually grew upon him, and in his later years it was only with difficulty that he accomplished any teaching at all, and his auditors were frequently anxious lest he should be unable to complete his lecture, so feeble and distressing was his appearance. In 1897 he resigned the chair, and for the last year of his life was a victim of paralysis, which completely disabled him. He died on February 6, 1901, leaving behind him a record of valuable services to the University and to the science which he loved, and the memory of an intellectual and genial personality in the minds and hearts of all who had the privilege of his personal acquaintance. W. E. H.

NOTES.

Reference was made in our issue for February 28 to the retirement of Sir A. Geikie from the office of director-general of the Geological Survey, and to the appointment of Mr. Teall as successor. Mr. Teall takes the title of director of the Geological Survey and Museum, and the further changes in the staff (which date from April 1) are as follows: Mr. H. B. Woodward to be assistant director (for England and Wales), and Mr. John Horne to be assistant director (for Scotland); Mr. C. Fox Strangways, Mr. Clement Reid and Mr. Aubrey Strahan to be district geologists for England and Wales; Mr. B. N. Peach and Mr. W. Gunn to be district geologists for Scotland; and Mr. G. W. Lamplugh to be district geologist for Ireland.

Sir Archibald Geikie will be entertained at a complimentary dinner on May 1, as a mark of recognition of his services to geology, and in commemoration of his recent retirement from the position of director-general of the Geological Survey and

director of the Museum of Practical Geology. The dinner will be given at the Victoria Hall, Criterion Restaurant, and the chair will be taken by Lord Avebury. The committee includes many distinguished and representative men of science, among them being Lord Kelvin, Lord Lister, Sir William Huggins, K.C.B., Sir Norman Lockyer, K.C.B., Sir John Murray, K.C.B., Sir Michael Foster, K.C.B., Sir William de W. Abney, K.C.B., Sir William Turner, K.C.B., Sir Henry Howorth, K.C.I.E., and Profs. Judd, Bonney, Le Neve Foster, McKenny Hughes, J. Geikie, Ray Lankester and Lapworth, as well as a number of other Fellows of the Royal Society. Tickets for the dinner can be obtained from the honorary secretary of the committee, Mr. F. W. Rudler, 28, Jermyn Street, S.W.

PROF. HUMBERT has been elected a member of the section of geometry of the Paris Academy of Sciences, in succession to the late M. Hermite.

THE summer meeting of the Anatomical Society of Great Britain and Ireland will be held in the Yorkshire College, Leeds, on Friday and Saturday, July 5 and 6.

WE learn from *Science* that Dr. Robert Bell has been appointed director of the Geological Survey of Canada, in succession to the late Dr. G. M. Dawson; and that Dr. S. W. Stratton has been appointed director of the newly-established U.S. National Bureau of Standards, by Mr. McKinley.

THE Easter excursion of the Geologists' Association will be to Kingsbridge, Salcombe and district, under the direction of Mr. W. A. E. Ussher and Mr. A. R. Hunt. The members taking part in the excursion will leave Paddington on the morning of Thursday, April 4, and return on the following Tuesday evening.

IT is announced from Berlin that the German Emperor has abandoned his original intention of opening in person the forthcoming fifth International Congress of Zoology, which is to be held in the German capital on August 12-16, and that, in consequence of a special desire on the part of the Empress, the German Crown Prince has undertaken to perform this task.

MR. VAUGHAN CORNISH has returned from an expedition in search of snow-waves in Quebec, Manitoba, the North-West Territories and British Columbia. These waves were found to be well developed on frozen rivers and lakes and on the open prairie, where photographs and measurements were taken. They are produced without the intervention of any obstruction, and sometimes occur in groups or trains of waves comprising a hundred succeeding ridges. Their movement is sufficiently rapid to be readily visible. In certain conditions of the snow true ripples are also formed, which are similar to the ripples produced by wind in loose dry sand. In both ripples and waves the steeper face is on the lee side. In moist or coherent snow, such as usually falls in England, the wind carves the surface into ridges which have their steep face on the windward side.

AN outward and visible sign of progress in the arrangements for the British Antarctic expedition which in July or August will set out under the auspices of the Royal Society and the Royal Geographical Society, was shown by the successful launch of the *Discovery*, the ship specially built for the expedition, at Dundee on March 21. Lady Markham christened the vessel, which, when completed, will cost about 50,000*l.*; and at a banquet held after the ceremony Sir Clements Markham referred to the lack of geographical knowledge of Antarctic regions and the opportunities which will be afforded for the study of the great ice barrier. The purely exploratory work of the expedition will, of course, be of interest, and as that appeals to the public mind it is perhaps expedient to give prominence to it. But the necessity for the expedition lies in the absence of information concerning the natural history, physics and meteorology of the south polar regions, and it is with the provision made for the investigation of these subjects that men of science are most concerned. We are glad, therefore, to know that the scientific work of the expedition is in the hands of Prof. Gregory.

IN the House of Commons on Friday, Sir J. Rankin asked the President of the Board of Agriculture whether he would consider the desirability of establishing pomological stations in convenient parts of the country for the purpose of making experiments in the growth of the apple and pear, so as to enable persons employed in the fruit industry to obtain trustworthy information. In reply, Mr. Hanbury said: "Stations for agricultural and horticultural experiments have not hitherto been established directly by the State itself, and in the case of apples and pears, which depend so much upon the climate in which they are grown, no one central station would be of much use, and it is only by local agency that experiment stations could be established in so many varying districts. Both in the North and South of England there are institutions, aided either by the local taxation grants or by direct grants from the Board of Agriculture, in which experiments are made in the growth of pears and apples, and this appears to be the proper system to be adopted in those districts, such as Herefordshire, where there is a special interest in the growth of these fruits."

AN account of the work of M. Théodore Moutard, the mathematician, whose death was recorded last week in these columns, is given by M. G. Darboux in the *Comptes rendus*. After leaving the École Polytechnique, Moutard for a long time devoted himself to private teaching, preferring this course to serving under the Government, and he soon established for himself a unique reputation. But in 1870 he returned to the School of Mines, and he rendered valuable services as Inspector-General of Mines. The second part of his career was thus spent in the midst of a circle of congenial and distinguished colleagues. Moutard rarely published papers, but what he did write was of great value. To him we are indebted for the theory of anallagmatic surfaces, and especially of those of the fourth order or *general cyclides*, and Moutard's theory has formed the basis of numerous developments by Laguerre, Rebacour, Mannheim and Humbert. In the theory of partial differential equations of the second order, with two independent variables, Moutard gave a complete solution of an important problem. His manuscript, presented to the Academy, was burnt by the Communists at Bertrand's house; but Moutard re-wrote the most important portions, and the remainder of the theory was re-established by Cosserat. Moutard also wrote some valuable notes to Poncelet's *Applications d'Analyse et de Géometrie*, and his use of elliptic functions in connection with Poncelet's theorems on inscribed and circumscribed polygons has been characterised by Halphen as one of the best and most profound writings on this interesting subject. Moutard sought no distinctions, and never became a candidate for membership of the Paris Academy, although the section of geometry of that body recognised his merits by awarding him the Petit d'Ormoy prize, the highest honour that could be conferred on him. He kept a great many of his writings unpublished, although repeatedly urged to allow them to be printed.

IT is with much regret that we record the death, on March 7, of Mr. Arthur Coppen Jones, known to the scientific world as the translator of Fischer's "Lectures on Bacteria," and by an important paper, published in the *Centralblatt f. Bacteriologie und Parasitenkunde* in 1895, in which he sought to establish the revolutionary discovery that the tubercle bacillus is probably no bacillus at all, but a stage in some hyphomycetous fungus. Mr. Jones was one of the last set of students who worked under

Huxley at the Royal College of Science, and he there distinguished himself by taking the Forbes medal. Full of enthusiasm, he laid his plans to return to the College in the following session for the work of investigation, but an exceptionally severe constitutional breakdown prevented him from so doing. He was ordered to Davos, and he there spent the rest of his life, with the exception of brief periods of absence passed in study at the Universities of Zurich and Berlin, he being attracted to the latter city by the now famous investigations of Koch. While at Davos, Jones developed a practice as a consulting bacteriologist, working and experimenting whenever he was able. He did not hesitate to submit even his own person to experiment, and in one of his letters he admitted himself enamoured of the Richet muscle-plasma treatment, with which he experienced an immediate success. In the closing year of his life, Jones returned to some experiments he had previously made upon the physiological effects of air at high altitudes, but to no purpose, for the end came suddenly and peacefully, a tubercular cystic trouble necessitating an operation, which, while affording relief, proved of no permanent value. He was buried at Davos, where his loss will be severely felt.

WE have received a pamphlet setting forth in concise form a history of the progress and present status of the work of the Concilium Bibliographicum at Zürich, which for the past five or six years has been maintained at considerable pecuniary risk by Dr. H. H. Field, who in successive periods has had to face a deficit ranging from 5625 francs for each of the first three years to 224 for the last. The official foundation of the institution was by a vote of the third International Congress of Zoologists, at their meeting in Holland of 1895, and the experimental stage of its work has now passed. The Swiss Society of Naturalists, who have all along been among the foremost supporters of the undertaking, have with commendable enthusiasm induced the Swiss Government, by a recent vote of its Parliament, to increase five-fold a subsidy with which during recent years it has generously endowed the work. There is hereby insured the future permanence of the enterprise, which now becomes independent of the person of its present director. The pamphlet gives, in addition, an analytical table of the cards and other bibliographic materials which have emanated from the Bureau, and a register of the distribution of the cards in the chief divisions of the bibliography. Terms of subscription, an outline scheme for future development, with an ambitious programme for the present year, bring the pamphlet to a close, except for the remark that a removal has recently been made to more spacious quarters. Acknowledgment is made of support received from the Elizabeth Thompson Science Fund, and while we would congratulate Dr. Field upon this and the encouraging circumstances under which he starts work for the new century and wish him every success, we would recommend to the consideration of zoologists and bibliographers at home the fact that Cape Colony takes about as many cards as the whole of England. This is a condition which simply should not be, and denotes a poor return for the services done.

THE April Pilot Chart for the North Atlantic and Mediterranean has just been published by the Meteorological Council. It follows the same arrangement as that for the January specimen chart described in our last number. But of course there are, in all directions, important changes in the details. There are some interesting features connected with the winds and currents, particularly the modifications in the set of the currents off our western and south-western coasts, which are, no doubt, due to the prevalence of polar winds off the coasts of north-western Europe in the spring months, causing a surface drift to the westward and south-westward, and interfering with the normal flow of the Gulf Stream. Many subjects are dealt with in the letterpress, but prominence is given to fog and ice about the banks of Newfoundland, these dangers increasing with the opening of navigation of the St. Lawrence Gulf and River for the summer. It is explained that the fogs of this locality have certain peculiarities, the knowledge of which may be of no little service to the seaman. Thus, with the wind blowing from the sea towards the land, the fog is generally of no great density, for objects can often be sighted at a distance of half a mile, but with calm fogs following strong winds nothing can be seen at fifty yards from the deck, yet at a height of fifty or sixty feet in the rigging it may be possible, at the same time, to see almost any distance round. Up to the time of going to press no ice had been reported on the Grand Banks this season, the weather off St. John's, Newfoundland, on the 8th inst. being favourable, and no ice to be seen, so that it does not look like a great ice year.

FOR several years past the Deutsche Seewarte, Hamburg, has made strenuous efforts to accelerate and improve the service of telegraphic weather reports. The subject has been discussed both at international meetings and at conferences of the heads of the German meteorological systems, and it is recognised on all sides that the present service can be materially improved by a more speedy collection, discussion and publication of observations. So long ago as 1872 a very perfect system was introduced in the United States, called the circuit-system, in which the necessary wires over certain telegraph lines are reserved exclusively for the transmission of meteorological messages for a time after each observation. This method has been found to work very satisfactorily in the United States, but in Europe, where the control of the wires is in the hands of various countries, the difficulty of introducing a similar method is insurmountable. The system recommended by the Deutsche Seewarte is called the radial-system, in which the observations pass through the central offices. Special observations have been made for nearly a year at 8 a.m. mid-European time, or at about 7 a.m. Greenwich time, at some thirty-five stations in various countries, including several in the British Islands, and forwarded to the Deutsche Seewarte, which enable the Hamburg office to issue reports as early as 9 a.m.; and the early publication of this information has been found to lead to such satisfactory results as to warrant a considerable extension of the plan in the near future. The method is fully discussed and explained by Dr. van Bebber, in the February number of *Das Wetter*, in an article entitled "The Present Condition of Weather Telegraphy."

WE have received a copy of the year-book of the Austrian Meteorological Office for 1899, containing daily observations at twenty stations, hourly observations for Vienna, and hourly means and monthly and yearly summaries for a large number of stations. During each winter the Vienna thermograms show some anomalous jumps of temperature, amounting to 3° to 5° C. and at times reaching even to 10° in half an hour, or less. The mild winter of 1898–9 exhibited several such cases, and these have been made the subject of an interesting discussion by Mr. Max Margules, who has compared the thermograms of Vienna with those of two places situated some 30 or 40 miles to the east and west of that place. In very sudden rises of temperature it is a matter of considerable importance to know what is taking place above. In all cases it was found that at a relatively greater altitude, say 500 to 800 metres above the lower stations, the warmer temperature occurred some hours or even a day earlier than at the lower stations. The subject has been discussed with reference to the following conditions:—(1) A progressive increase of temperature in the upper air; (2) a constant temperature above; (3) an increasing temperature below with a decreasing temperature in the higher strata of the atmosphere.

THE remarkable subsidences which have often occurred in and around the town of Northwich, in Cheshire, form the subject of a paper by Mr. T. Ward, recently issued by the Institution of Mining Engineers. The subsidences are chiefly due to mining in the Upper Bed of rock-salt, and the too rapid removal of brine by means of modern pumps. In a natural condition the water in or on the salt-beds becomes saturated with salt and then ceases to dissolve it, but now the brine is continually pumped up in immense quantities, and the fresh water which flows to take its place dissolves the salt pillars which have supported the roof and overlying strata, with the result that there is a depression towards each pumping centre. In almost every case the mines in the Upper Bed of rock-salt are destroyed by water rapidly eroding the salt pillars in this way. Another cause of subsidence is the pumping of brine from off the rock-head, that is, the surface of the Upper Bed of rock-salt. These are by far the most serious and widespread, and it is from them that the town of Northwich suffers so much damage. Owing to the subsidences, which show themselves first by small cracks in the buildings, and in doors and windows refusing to shut, a system of framework buildings has been allowed, so that when a building sinks it can be lifted by screw-jacks and put back to its original position. By degrees the town is becoming one of framework buildings, and will, for England, be unique in this respect. The accompanying illustration, which we are enabled to give from Mr. Ward's paper, shows a subsiding house in a street at Northwich.

WE learn from the *Scientific American* that Mr. Edison has recently taken out a patent for a method of obtaining permanent phonographic records. The wax cylinder on which the impressions due to the speech have been made in the usual way is first coated with an extremely thin layer of gold; this is effected by revolving the cylinder in a vacuum between two gold electrodes between which a vacuum discharge is passing. This thin layer of gold is backed up with copper by electro-deposition and the wax is removed, we imagine by melting it off. Upon the copper matrix thus obtained a deposit of silver is thrown down electrolytically, and when this is of sufficient thickness the copper is dissolved off. The remaining silver deposit will retain the thin layer of gold and will be an exact reproduction of the original wax record, but one much more capable of standing repeated use. The value of the invention depends obviously on the fidelity with which the final silver record reproduces the original sounds; if the reproduction is accurate the process is a very useful one, since a phonographic record which is at once faithful and permanent should be of considerable value for historical purposes.

IN the February number of the *Victorian Naturalist* Mr. A. J. North continues his observations on the geographical distribution of Australian birds.

A RECENT issue of the *Bulletin* of the Illinois State Laboratory of Natural History (vol. v. art. 12) deals with the local fauna of leeches (Hirudinea), of which several new forms are described. The occurrence of certain European species is especially noteworthy. Several beautiful plates illustrate the morphology of some of the more remarkable types.

IN its Report for the past year the Oxfordshire Natural History Society and Field Club sets an excellent example to associations of a similar nature by the publication of the first instalment of a local fauna. The group dealt with on the present occasion is the Hymenoptera Aculeata, comprising ants, wasps and bees. The local list is also issued in a separate form, printed only on one side of the paper for cutting up to label collections.

DR. L. STEJNEGER sends us a copy of a paper on the North American wheatears (*P. U.S. Mus.* xxiii. p. 473), in which it is shown that a race of these birds habitually breed in North America. From the differentiation of this Greenland race the author thinks we are justified in inferring that the Greenland-Iceland-England line of migration must be considerably older than the Alaska-Tchuktchi-Udski route, since it has resulted in the establishment of the local variety of the wheatear forming the subject of this communication.

TWO papers in the March issue of the *Quarterly Journal of Microscopical Science* record important advances in our knowledge of the lancelets. In the first Dr. A. Willey describes a new subgeneric type of these primitive chordates from the Orissa coast, under the name of *Branchiostoma* (*Dolichorhynchus*) *indicus*. The distinctive characteristic is the anterior prolongation of the notochord and head-fin; so that this form is exactly the opposite of *Heteropleuron* (*Asymmetron*) *lucayanum*, in which these parts are extended in the other direction. In the second communication Prof. W. B. Benham describes the New Zealand lancelet as *Heteropleuron hectori*. It may be mentioned that, according to modern ideas of nomenclature, the name of the first subgenus of the typical group should be Branchiostoma, and not Amphioxus, which is a synonym.

To the same journal Mr. R. I. Pocock contributes an important memoir on the Scottish Silurian scorpion, with a figure of the specimen discovered in Lanarkshire in 1883. This the author makes the type of a new species, *Palaeophonus hunteri*. As the result of his investigations, Mr. Pocock concludes that Palæophonus apparently occupies a position intermediate between the king-crabs (Limulus) and the Palæozoic Eurypterids, on the one hand, and modern scorpions on the other, although, if anything, rather nearer the former than the latter. The Scotch species thus supplies a few more links to the chain of evidence connecting the line of descent of the modern terrestrial scorpions from marine ancestors more allied to the king-crabs.

We have the pleasure of congratulating Mr. T. Southwell, of Norwich, on the appearance, in the February number of the *Zoologist*, of the twentieth annual issue of his valuable "Notes on the Seal and Whale Fishery." The season's catch included 16 whales, 494 walruses, 53 seals and 145 bears, which yielded 230 tuns of oil and 219 cwt. of whalebone; in addition to which was the product of 1 whale, 138 walruses and 3400 seals, equal to 60 tuns of oil and 10 cwt. of "bone" from the Cumberland Gulf station. With oil at 22*l*. per tun, and sizable "bone" at 1400*l*. per ton, the estimated value of the take would be about 30,000*l*., as against 38,000*l*. in 1899. Owing to the bays in which they are usually beached being blocked with ice, no white whales were taken. Mr. Southwell is informed that the Greenland seas are not to be visited by any British whalers during the coming season. Commenting on the practical disappearance of the right whale from the Greenland seas, the author doubts whether this can be attributed to extermination, but is at a loss to determine where the remnant have gone. "As to the seals, the case is much more simple; the destruction year after year of a very large proportion, often virtually of the whole brood and of a large number of old seals in addition, congregated in a limited area, must inevitably tell in course of time, and sooner or later reduce the breeding pack to such an extent that they would be no longer worth pursuing, and even lead to their final extermination. This has doubtless, to a very large extent, been the case. The British vessels have quite abandoned the pursuit, and what there is left of the Greenland sealing is now quite in the hands of the Scandinavians, whose more economical outfits enable them to continue the struggle long after we have been driven from the field."

A BULKY volume just issued by the Government of India contains accounts of the trade carried by rail and river in India in the official year 1899–1900 and the four preceding years, compiled under the direction of the director-general of statistics.

A COLLECTION of tables showing the rainfall recorded on each day of every month from 1868 to 1899 at Dehra Dun has been issued by the Survey of India Department. The daily, monthly and annual means are also given.

THE following lectures will be given at the Royal Victoria Hall, Waterloo Road, during April, on Tuesday evenings:—"Waves and Oscillations," Mr. A. W. Porter; "Wild Nature at Home," Mr. R. Kearton; "Arctic Discovery," Captain Wiggins; "Our Field Crops as a Factory of Food," Mr. J. S. Dymond; "Facts about India: Plague and Famine," Mr. Birdwood.

WE have received a copy of *Kuhlow's German Trade Review and Exporter*. This paper is published in Berlin but is written in English, and contains some interesting translations from German and other technical papers on recent electrical work. The main object of the journal is to introduce German productions to foreign markets, and it is noteworthy as an example of the energy and perseverance with which the Germans are pushing their export trade.

THE *Rendiconto* of the Bologna Academy (iii. 1) contains a paper, by Prof. Ferdinando Paolo Ruffini, on the moments of inertia of a system of points not possessing a mass centre. The author examines, with the aid of certain formulæ already indicated by the late Prof. Beltrami, the disposition in space of the axes which in a given system of points having no mass centre (the sum of the mass constants being zero) have a given moment of inertia. The quadrics which are analogous to the ellipsoids of inertia in an ordinary system are also discussed.

IN a recent number of the *Revue générale des Sciences* Prof. A. Haller describes the contact process of sulphuric acid manufacture as used by the Badische Anilin- und Soda-Fabrik. In this process a mixture of sulphur dioxide and air is brought into contact with platinised asbestos at the proper temperature. The platinised asbestos is placed on perforated trays, supported in an upright tube which is so arranged that it can be heated or cooled by means of a current of air. The temperature at which the best results may be obtained depends upon the concentration of the sulphur dioxide and must be sufficiently high to start the reaction, but lower than the dissociation temperature of sulphur trioxide. A similar process has been in operation for a considerable time in this country and in Germany for preparing "Nordhausen" acid, but it has been found only workable when the mixture of sulphur dioxide and oxygen is pure, such as the mixture obtained from sulphuric acid by dropping it on to hot platinum. Presence of water vapour and other impurities causes the platinised asbestos to become inactive. In the Badische Fabrik process the sulphur dioxide is obtained by burning pyrites, and complete combustion of the sulphur and other oxidisable matter is attained by blowing jets of air and steam into the hot gas just as it issues from the burners. The gas is then washed and dried by passing through sulphuric acid. Before passing into the "contact" apparatus the mixture is examined optically, and must show no trace of cloudiness when viewed through a long tube. It is also chemically examined and must be free from arsenic. By proper regulation of the temperature up to 99 per cent. of the sulphur dioxide is converted into sulphur trioxide. The sulphur trioxide is dissolved in water, and for the production of acid of higher concentration than 60 per cent. the process is more economical than the lead chamber method. The claim is also made that better acid is produced, since it contains no arsenic, nitric compounds or lead.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mrs. F. Page; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mrs. Horrell; a Senegal Touracou (*Turacus persa*), a Great-billed Touracou (*Turacus macrorhynchus*) from West Africa, presented by Mr. G. A. Corder; a Goshawk (*Astur palumbarius*), European, presented by Mr. C. Schaible; four Chameleons (*Chamaeleon vulgaris*) from North Africa, presented by Mr. W. F. Cornelius; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a Grey Ichneumon (*Herpestes griseus*) from India, deposited; a Tasmanian Wolf (*Thylacinus cynocephalus*) from Van Dieman's Land, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL.

April 1. 15h. 56m. Transit (egress) of Jupiter's Sat. III.
2. 8h. 23m. Minimum of Algol (β Persei).
3. 18h. 0m. Mercury at greatest elongation, 27° 48′ West.
4. 11h. 59m. to 13h. 18m. Moon occults B.A.C., 4531 (mag. 5·7).
7. 15h. 59m. to 17h. 19m. Moon occults ω^2 Scorpii (mag. 4·6).
7. 16h. 5m. to 16h. 20m. Moon occults ω^1 Scorpii (mag. 4·1).
15. Saturn. Outer minor axis of outer ring = 15″·96.
15. Venus. Illuminated portion of disc = 0·998.
15. Mars. Illuminated portion of disc = 0·924.
20–21. Epoch of Lyrid meteoric shower (Radiant 270° + 33°).
22. 10h. 5m. Minimum of Algol (β Persei).
22. 10h. 25m. to 11h. 11m. Moon occults χ^2 Orionis (mag. 5·9).
27. 7h. 40m. to 8h. 31m. Moon occults 19 Sextantis (mag. 6·0).
30. 10h. Jupiter stationary.

NEW VARIABLE STARS.—Mr. Stanley Williams announces the discovery of a new variable star in Perseus having the position

$$\left.\begin{array}{l}\text{R.A.} = \quad 3\text{h. } 17\text{m. } 51\cdot 80\text{s.}\\ \text{Decl.} = +\ 43^\circ\ 39'\ 55''\cdot 6\end{array}\right\}(1855).$$

The star is B.D. $+43^\circ\cdot 726$, catalogued as 8·9 magnitude, and is in the same field as Nova Persei with a low power.

The following magnitudes have been determined from photographs obtained with a 4·4-inch portrait lens.

1900.	Dec. 22	...	11·63 Mag.
1901.	Jan. 11	...	11·47
	25	...	10·97
	Feb. 11	...	10·87
	20	...	10·80
	28	...	10.53

The visual magnitude of this star is considerably brighter than the above photographic measures. Espin classes the star R in his "Stars with Remarkable Spectra."

Dr. T. D. Anderson announces a new variable in Andromeda, whose position is

$$\left.\begin{array}{l}\text{R.A.} = \quad 0\text{h. } 43\cdot 5\text{m.}\\ \text{Decl.} = +\ 33^\circ\ 35'\end{array}\right\}(1855).$$

The magnitude of the star has varied as follows:—

1900.	Oct. 5	...	$<$11·2
1901.	Feb. 16	...	10·7
	March 10	...	10·2.

Astronomische Nachrichten (Bd. 155, No. 3698).

LIGHT CURVE OF ALGOL.—Prof. A. A. Nijland, of Utrecht, contributes an article to the *Astronomische Nachrichten* (Bd. 154, No. 3695), containing the results of a numerous series of determinations of the brightness of Algol during its variation, and gives the light curve deduced therefrom. As shown, the variation is not symmetrical with respect to the minimum, a break occurring on the passage from maximum to minimum.

CHART FOR OBSERVATIONS OF NOVA PERSEI.—The first of a series of charts for use in observations of Nova Persei has been prepared by Father Hagen, of Georgetown College Observatory, and has recently been issued. The publication consists of a map of the region surrounding the Nova, showing stars down to the sixth magnitude, and a catalogue including all the stars shown on the chart, with their actual magnitudes and notes as to any peculiarities. A second series of charts is in preparation, and will be issued shortly.

PHOTOGRAPHY OF THE AURORA.

THE ever-changing form, and the faintness, of the aurora render this phenomenon a difficult subject to the photographer. Many have been the attempts to secure photographs of what have appeared to be brilliant displays, but the results have shown that little or no action had taken place on the photographic film, in spite of the fact that very rapid plates had been used. Herr Tromholt, who made a special study of the photography of the aurora, exposed very rapid plates to what he considered bright auroræ, and even with exposures from 4–7 minutes secured no trace of them. Later, at Christiania, he was more fortunate, and obtained an impression with an exposure of 8·5 minutes. To advance our knowledge of the changes in form of this phenomenon, it is important that photographs should be secured, if possible, in a few seconds, and not minutes. This seems now to be feasible, judging from an interesting account given in the *Meteorologische Zeitschrift* (Heft 6, 1900), by Herr O. Baschin. Herren Brendel and Baschin stayed several months, during the winter of 1891–92, at Bossekop, in Norwegian Lappland, to study the magnetic elements and the aurora.

For the photography of the aurora they employed an apparatus belonging to Herr. O. Jesse, who had used this instrument for photographing luminous night clouds. The objective had a focal length of 210 mm. and 60 mm. aperture; the dimensions of the plates used were 9 × 12 cm., the field photographed covering about 20° to 30°. Schleussner's plates were employed, and what appears to be the most important desideratum, the plates were stained (with erythrosine) and thus rendered more sensitive to the auroral light. For the first experiments the exposures given were comparatively long, namely three minutes, but these were found to be excessive; finally, seven seconds were sufficient to give good pictures. The reproductions accompanying the account of these researches illustrate the results secured with exposures of one minute and seven seconds respectively. The latter is reproduced here and shows very clearly the drapery-structure, although even this, according to Herr Baschin, is overexposed, the structure having a watery

FIG. 1.—Auroral-drapery on February 1, 1892.

and not sharp appearance. With such first results as these, there seems no reason why, with plates stained to be most sensitive to the particular colour of the aurora, and with the most rapid lenses, even shorter exposures of a second or less should not be given.

A step in the right direction has, however, been made, and the time is not far off when it will be as possible to project the ever-changing form of the aurora upon a screen as it is to exhibit in this way the phenomenon of an eclipse of the sun.

THE MISSISSIPPI RIVER.

THE Mississippi river, extending over a length of 2550 miles, has been placed by the United States Government under the charge of a Commission, whose duties include the making of a detailed survey of the channel from the headwaters to the Gulf of Mexico; a topographical survey showing the natural and artificial features lying within a mile of the river; a system of triangulation with base lines along the stream; longitudinal and cross sections of the channels; observations and records as to floods; and, for the assistance of future surveys, the placing, at intervals of three miles, of permanent marks, consisting of four stone or vitrified tile monuments placed in a line normal to the stream, two on each bank, about half a mile apart. The Commission has also the charge of the works carried out for regulating and deepening the channel.

Mr. J. A. Ockerson, who is a member of this Commission, and who, in the year 1899, made a survey of the headwaters of the Mississippi, contributed a paper on the subject to the *Proceedings* of the International Congress on Navigation held at Paris last year,[1] from which the principal part of the information here given has been obtained.

[1] "The Mississippi River: Some of its Physical Characteristics and Measures employed for the Regulation and Control of the Stream." By J. A. Ockerson, member of the U.S. Mississippi Commission Eighth Navigation Congress on Navigation. Recorded in English and French. (Paris 1900.

The Mississippi is one of the largest rivers in the world. It penetrates the heart of the most fertile portion of the United States for a distance of 2550 miles, and has 15,000 miles of navigable tributaries. Its headwaters rise amidst the pine-clad hills of northern Minnesota, where the long winters reach almost a polar cold, and winds its way through the varying conditions of climate of ten great States to the semi-tropical lowlands of southern Louisiana, finally losing itself in the Gulf of Mexico. Its drainage area, of over $1\frac{1}{4}$ million square miles, covers nearly half of the United States, and is equal to the whole of Europe exclusive of Russia. The region which it drains has no equal in any part of the world for fertility of soil and natural resources, such as vegetable products, timber, coal and minerals of various kinds. On its surface are borne immense cargoes of grain, coal and lumber gathered from the resources of a vast district and despatched across seas to all parts of the world. In its upper reaches it affords power to innumerable saw-mills and flour-mills and manufacturing industries.

The source of this great river has long been the subject of controversy. The earliest white explorers who first visited the country where the Mississippi rises were the French fur traders, but the earliest authentic account of the exploration of its source is that of William Morrison, who visited the district in 1804. The next explorer who recorded the results of his survey was R. H. Schoolcraft, in 1832, who located the headwaters in Lake Itasca. In 1872 the *New York Herald* sent a representative to visit the source of the river, with instructions to navigate the stream thence to the Gulf of Mexico. Again, in 1879, the *Louisville Courier Journal* sent an expedition to Itasca Lake. It was not, however, until 1889 that the first thorough exploration of the basin was made under the direction of the Minnesota Historical Society.

The State of Minnesota has set aside a reservation of 35 square miles, covering the basin of Lake Itasca, thus preserving for ever sacred the source of the father of rivers in the "Itasca State Park."

Unlike the origin of most large rivers which commence as mountain torrents, the Mississippi leaves its source with a width of 30 feet and a depth of 5 feet, and starts on its journey at an altitude of 1560 feet above sea-level. Commercial navigation reaches to within 25 miles of the lake, and thousands of sawn logs are floated down the stream every summer. At about 60 miles from the source the Government have constructed reservoirs, capable of holding 93,746 million cubic feet of water, for the purpose of regulating the supply of water to the channel and maintaining a navigable depth in summer. Near St. Anthony, about 500 miles from the source, are rapids which have been made use of obtaining water-power for working saw and flour mills and other manufacturing industries. Steamboat navigation commences near the junction of the Minnesota river, where the river has fallen 870 feet, 548 miles from the source.

A little above the junction with the Ohio, about 1400 miles down, the water becomes heavily charged with sediment and the country is subject to be flooded. The extreme range between high and low water at St. Louis is 37 feet. The slope of the water here falls six inches in a mile. Sand bars are numerous, and although the discharge amounts to 35,000 cubic feet a second in dry seasons there is not frequently more than four feet over the bars. Works are being carried out along this length for regulating the width of the channel and dredging away the bars so as to secure a better navigable depth. Where the banks are subject to excessive erosion they are protected by mattresses of woven willows, and the banks graded by hydraulic action. A description and illustration of this work was given in NATURE of December 19, 1896. Along this reach the river is exceedingly crooked. Between Arkansas and Greenville the distance along the river is 40 miles, the air line being only 15 miles. It also has great width, the banks, which are from 30 to 40 feet high, being in places two miles apart. The maintenance of these "levées" or banks is of vital importance to the surrounding country, as a breach would result in the inundation of 50,000 square miles of rich alluvial land.

One of the greatest difficulties which the management and the navigation has to contend with is the immense amount of drift-wood carried down in floods. This wood, if not cleared away, gets caught in the bends and accumulates, forming with the alluvial matter an effective barrier to the flow of the water and a source of danger to the banks. For the removal of this drift-wood special vessels, called snag-boats, are employed, which patrol the river and remove the snags.

Dredgers of large type, and provided with very powerful machinery, are in constant employment for removing sand bars and shoals. The type now almost universally in use for this purpose are worked by centrifugal pumps, which raise the sand and in some cases deliver it over the banks. Where the material is hard, cutters are provided at the end of the suction pipes of the pumps, which loosen the clay or hard material sufficiently to allow of its being sucked into the pipes. One of the most recent of these machines is capable of raising more than 4000 cubic yards of material an hour, and is fitted with electric light, machine shops, and all appliances necessary to repair the machinery and keep it in going order.

For the lower part of its course the river winds its way through a vast delta, twisting and turning by numerous bends until it extends its length to nearly double the point to point length of the delta. This delta is 500 miles long, and from 30 to 40 miles in width, covering an area of 400,000 square miles. It is composed of material transported by the current and deposited in the estuary, which at one time extended from the original outfall to the Gulf of Mexico. The river is still pouring solid matter into the Gulf, where it is spread out in a fan-like shape over a coast-line of 150 miles and is filling it up at the rate of 362 million tons a year. Some idea of the vastness of the silent operations of nature may be conceived when the fact is considered that this solid matter consists of the wearing away of the land through which the river flows, and that some of it must have been transported a distance of over 3000 miles; and that if the whole of it had to be carried in boats for half the total distance at the lowest rate at which heavy material is carried on the inland waterways of America, or, say, for one-tenth of a penny per ton per mile, the annual cost of transport would amount to no less a sum than 238 millions of pounds.

The channel in the lower reach is narrow, not exceeding half an mile in width, the depth in places exceeding 200 feet, and everywhere sufficient to float large sea-going craft as far as the junction of the Red river, a distance of more than 300 miles.

On this length is situated the city of New Orleans, 110 miles above the Gulf of Mexico. Ships of all nations reach this port. Its wharves extend over fifteen miles of river front, and are crowded with vessels of every description. Grain and cotton form the chief item of export.

As the river approaches the Gulf it is split up into three principal channels. The smaller of these has been improved by training walls made of mattresses and stone, which extend over the bar out into the deep water of the Gulf for more than two miles. This work was undertaken by Captain Eads, under contract with the Government to provide, for a certain sum of money, a depth of twenty-six feet at low water and to keep and maintain this depth for a period which has now expired.

The description of this mighty river above given will surely warrant its being called the "Father of Waters."

W. H. WHEELER.

HISTORY AND PROGRESS OF AERIAL LOCOMOTION.[1]

WHILE history contains no records of any past age in which men rode bicycles, the question of aërial locomotion has occupied the thoughts of man from the days of the Egyptians, to whom we are indebted for a representation of a man with wings considerably resembling the gliding machine on which Mr. Pilcher lost his life. Passing by the legend of Daedalus, whose invention of sailing ships led to the tradition that he attached wings to himself, we find in history numerous records, some such as that of Dante of Perugia or the chronicle of Busbequius, referring to gliding experiments which may not improbably have been authentic, others describing machines by which men have tried to raise themselves by their own exertions, but without success, as exemplified by Besnier, the Marquis de Bacqueville, Jacob Deghen, while a far larger number have been handed down to us of designs of fantastic machines for navigating the air, of a purely visionary character. In the latter category we must include in past times the grotesque figures

[1] Abstract of a Discourse delivered at the Royal Institution on Friday, February 8, by Prof. G. H. Bryan, F.R.S.

designed by Barthelemy Lourenço in Portugal, by the novelist Retif de la Bretonne, by Blanchard, before he became noted as a balloonist, and the prospectus of the Minerva issued by one Robertson when interest in ballooning was at its height. Even in recent times equally absurd devices have been promulgated, such as aërial tramcars supported by cigar-shaped gas vessels, not one-hundredth of the size necessary to raise such loads, and seats in such aërial tramcars with cavities filled with gas whose actual lifting power would amount to a few milligrams, and others.

The problem of aërial navigation, *i.e.* of performing *directed* journeys in the air, made no progress until Montgolfier's invention of the balloon. This rendered it possible to ascend in the air, but did not enable the motion to be directed, and from that time on aëronauts became divided into two classes: those who sought to navigate the air with balloons that rendered their apparatus lighter than air, and those who experimented with machines heavier than air but supported on structures resembling wings.

Balloons have often proved invaluable in times of war, and the war in South Africa has been no exception, thanks partly to the exertions of Major Baden-Powell. But the most practically useful application of the balloon in times of peace was inaugurated by Glaisher's ascents into the upper regions of the atmosphere for the purpose of obtaining meteorological data, and it is only recently that the balloon has been superseded for this purpose by the kite now largely used in America.

The experiments of Count von Zeppelin last summer, amounting as they did to the performance of a directed journey through the air, in some cases against a head wind, enable us to say that a solution of this problem was obtained before the end of the nineteenth century. The only previous achievement approaching von Zeppelin's was that of Messrs. Renard and Krebs in 1885 with the French war balloon, "La France." These experimenters on one occasion actually succeeded in performing a journey in the air and returning to the starting-point; but as the feat was never repeated and the speed of their balloon is stated by one writer at four and by another at fourteen miles an hour, it is somewhat difficult from such conflicting evidence to estimate the amount of success achieved. The speed attained by Count Zeppelin's balloon was about eight metres per second, say seventeen and a half miles an hour, and agreed very closely with that predicted by calculation, viz., 8·12 metres per second. With lighter and more powerful motors Count Zeppelin hopes to increase the speed by 50 per cent. The chief features of this machine are (1) its division into seventeen compartments, which prevents the gas from collecting at one end or oscillating in the balloon in such a way as to increase the resistance; (2) the distribution of the load at two points instead of at the centre, which reduces the mechanical difficulty of supporting a heavy weight by a cigar-shaped balloon.

The subject of dynamical flight without the aid of balloons opens up three fields of study:—(1) experiments on the air-resistance of planes and curved surfaces, systems of such aëroplanes and aërocurves variously arranged, and propellers; (2) the construction of motors of minimum weight per horse-power, using the sources of energy of minimum weight per foot-pound; (3) experiments on the balance, stability and control of aëroplanes and aërocurves. A historic retrospect of the work done in the past century includes Captain Le Bris's gliding experiments with his "artificial albatross" in 1854; De Villeneuve's reported feat of raising himself into the air, in 1870, by a machine driven by steam supplied from a flexible hose; the experiments on air resistance conducted in 1871; Langley's confirmation, in 1891, of Duchemin's formula for the thrust of an oblique current on a plane area, and his proof of the law according to which the horse-power per unit of weight lifted decreases with the speed; and Phillips's Wealdstone experiments on the advantages of narrow superposed planes over wide planes of equal area.

Coming to the question of horse-power, the chief interest in Sir Hiram Maxim's famous experiments centred round his engine, with which he obtained 362 horse-power, the machine weighing about 8000 lbs. Langley and Hargreave are stated to have designed motors weighing 7 and 10 lbs. per horse-power respectively; while Da Pra has made theoretical calculations in connection with designs of an aërial machine from which he concludes that such a machine could be made capable of carrying a motor weighing 15 kilograms per horse-power. A more experimental treatment of the question of horse-power is afforded by estimates of the rate at which work is done by gravity in the gliding experiments of Lilienthal, Pilcher and Chanute, from which it appears that about 2 horse-power would be required to support the machines. Mr. Chanute further estimates the possible weight of the motor per horse-power in a one-man machine at 4 lbs. for screws, 8 lbs. for wings, and 14 lbs. for aërocurves.

But the most difficult question connected with the flying machine is its balance and stability under the conditions ordinarily prevailing in our atmosphere. The very fluctuations of wind velocity which may furnish a source of energy for birds in sailing flight vastly increase the danger of experiments on artificial flight. It is easy to construct a glider which when dropped in a room from any position will right itself and begin to glide before reaching the ground; but the same glider when let fall from a window will continue to roll over and over and fall to the ground. More than thirty years ago Mr. Wenham made a model which would glide well from a window, but when let fall from a balloon in one of Glaisher's ascents it overturned after descending twelve yards.

Of the three, Lilienthal, Pilcher and Chanute, who have done most to solve this question of balance and stability, the two first met with fatal accidents just when their experiments were becoming most successful, and we are naturally led to compare their methods with those adopted by Mr. Chanute.

Both Lilienthal and Pilcher used machines with broad curved wings, the former preferring two superposed aërocurves and the latter adopting a single-surfaced machine. In both machines the wings were rigidly fixed, the operator relying on the movements of his body to counteract the effects of any sudden gust of wind tending to overturn the machine. Chanute, on the other hand, experimented with narrow superposed wings, some of his machines having as many as eleven or twelve aërocurves, arranged in pairs. Instead of balancing himself by his own agility, the wings were movable about pivots and were held in position by springs in such a way that their displacements, caused by a sudden gust of wind, gave the machine a tendency to right itself. Finally, a two-surfaced machine with narrow superposed rectangular surfaces, also with automatic balancing arrangements, was devised by Mr. Herring. With this machine, gliding was possible in winds of 31½ miles an hour, the greatest wind velocity in Lilienthal's experiments having been only 22 miles an hour, and little practice was required to control the machine. Practically no motions of the body were needed when a gust of wind struck the machine in a fore and aft direction, and but little movement was needed in the case of a side gust. The longest glide was 927 feet, and was performed by "quartering," *i.e.* sailing parallel to the side of a hill up which the wind was blowing.

The experiments of Messrs. Chanute and Herring constitute a distinct advance in the construction of gliding machines, and lead us nearer to the possibility of obtaining a true flying machine propelled by a motor. The addition of such a motor, if only by increasing the weight of the apparatus, would largely add to the difficulty of controlling it in the first trials, and the action of the propeller might considerably affect the balance. It is not improbable that after the first start is once made, the motor-driven machine may prove to possess greater steadiness in flight than the present gliders. In the former the thrust of the propeller is fixed relative to the body, in the latter the only motive force, due to gravity, is fixed in space, and Mr. Herring's experiments indicate greater stability under the first-named condition. How to perform the first experiments with the motor-driven machine is the difficulty which now awaits solution. If a large motor be used, the machine becomes too heavy to be readily controllable; if the dimensions of the machine are kept down it becomes the more difficult to construct a sufficiently light and powerful motor. The automatic regulating mechanism of Messrs. Chanute and Herring, by minimising the effort required in ordinary balancing, may render it possible for a man possessing the gymnastic skill of a Lilienthal or a Pilcher to overcome by his agility the new difficulties, introduced, at least in its early stages, by the motor. But in the transition from the gliding machine to the flying machine proper a wide gap has to be bridged, and it is little wonder that experimenters hesitate before taking a step which may introduce unforeseen dangers. It is by reducing the difficulty of balancing large machines, on the one hand, and reducing the weight of motors on the other, that we must hope to arrive at an experimental demonstration of the possibility of artificial flight.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. W. E. THRIFT has been elected Erasmus Smith professor of natural and experimental philosophy in Trinity College, Dublin, in succession to the late Prof. G. F. Fitzgerald.

WE are glad to notice in the report of the committee of the Bristol Museum that interest in nature study is encouraged by various means. In one of the rooms of the Museum, three aquaria containing the ova of the common frog, and the common and crested newts, were arranged, in order that the various stages of development passed through by these forms might be seen by visitors. The aquaria proved of especial interest to young people from schools. Lectures have been given by Mr. H. Bolton, the curator, to the students of evening continuation schools, and the Museum has been visited by a number of classes from other schools. The committee record that definite steps have been taken to provide the additional accommodation that has long been needed. The proposal took the form of providing for museum extension in conjunction with the establishment of a municipal art gallery, and the generosity and public spirit of Sir William Henry Wills has made this possible. Upon the basis that the sum of about 30,000*l.* would be required to provide a suitable building for both purposes, Sir W. H. Wills offered that if 10,000*l.* were provided for museum extension on the site adjoining the present building, he would provide for the completion of the scheme. This munificent offer was accepted by the council, who also accepted a report of the joint libraries and museum committees recommending the requisite application to Parliament, and placing the administration of the proposed art gallery in the hands of the museum committee.

IN connection with the London School of Economics and Political Science, Lord Rosebery delivered an address on commercial education at the Mansion House on Thursday last. The Lord Mayor, in opening the proceedings, stated that the object of the school was to provide a scientific training in the structure and organisation of modern industry and commerce and the general causes and criteria of prosperity as they were illustrated or explained in the policy and the experience of the British Empire and foreign countries. Mr. Passmore Edwards had generously contributed 10,000*l.* towards the erection of a building for the faculty of economics and political science; and Lord Rothschild had given 5000*l.* In the course of his address, Lord Rosebery said: "From whatever standpoint we may regard the age, I think we must all be aware that we are coming to a time of stress and of competition for which it is necessary that we should be fully prepared. It is not necessary here to indicate what form that stress or that competition may take, but in military matters, in naval matters, in commercial matters, in educational matters, we see more clearly day by day that we shall not be allowed to rest on any reputation that we possess already, but that we shall have to fight for our own hand in every department of human activity and human industry if we wish to keep our place. It is necessary for a nation in these days to train itself by every available method to meet the stress and the competition which is before it. Lord Salisbury said the other day—and I think with some truth—that it was impossible to define technical education. Well, I do not think it is impossible, but I think it is difficult. The way in which I should define it—very imperfectly, I am aware—is this. I should define it as education having a direct practical bearing on any definite industry or calling; that is to say, an education, not as we are accustomed to see secondary education as carried out in this country—an education for the training and elevation of the mind—but a practical training having a business bearing." The United States Ambassador, in proposing a vote of thanks to the Lord Mayor, said there was no doubt that colleges of economics and of political science were the latest development in the theory and practice of that education which was to fit men for the great affairs of life as they were developing in the complex and rapidly varying phases of modern civilisation. In the United States they regarded them as among the chief means of maintaining their part in that rivalry which they were maintaining, and meant to maintain with all their force, with their sister nations of the world, and especially with this country, to which they were so much attached—a rivalry not of arms or of warfare, but a rivalry of brains, of skill, of courage in the great industries of life.

SCIENTIFIC SERIALS.

Transactions of the American Mathematical Society, vol. ii. No. 1.—Invariants of systems of linear differential equations, by E. J. Wilczynski. The author has elsewhere shown that the most general point-transformation, which converts a system of n homogeneous linear differential equations into another of the same form and order, is

$$x = f(\xi),\ y_k = \sum_{i=1}^{n} \alpha_{ki}(\xi)\eta_i \ . \ . \ . \ (k = 1, 2, \ . \ . \ n),$$

where $f(\xi)$ and $\alpha_{ki}(\xi)$ are arbitrary functions of ξ, and the determinant $|\alpha_{ki'}(\xi)|$ does not vanish identically (*American Journal of Mathematics*, January 1901). In the present paper he considers those combinations of the coefficients of a system of linear differential equations which remain invariant when the system is transformed by the above transformation. These transformations form an infinite continuous group, and the author employs Lie's theory throughout, as Dr. Bouton has done in the *American Journal of Mathematics*, vol. xxi. No. 2. The applications of the theory are but lightly touched upon, and only a passing mention is made of covariants (p. 23) in this (first) paper.—Divergent and conditionally convergent series whose product is absolutely convergent, by Florian Cajori. Tests of the convergence of the product of conditionally convergent series have been worked out by Pringsheim, A. Voss and by Cajori (see *American Journal of Mathematics*, vol. xv. and vol. xviii., and *Bulletin* of the American Mathematical Society, vol. i. (1895). Two typical examples are discussed and also the author's general method.—Sets of coincidence points on the non-singular cubics of a syzygetic sheaf, by M. B. Porter. The points where a cubic can have an eighth order contact with cubics of the syzygetic sheaf are called by Halphen coincidence points of the cubic. The author considers certain geometrical relations that subsist between an inflexion triangle and its associated group of in- and circumscribed rectilinear triangles. The number of these triangles is 24. We give one property. Each in-circumscribed triangle is in six ways perspective with its associated inflexion triangle.—Note on non-quaternion number systems, by W. M. Strong. All number systems have been divided into the quaternion and non-quaternion systems, and Scheffers has shown that the n fundamental units of a non-quaternion system may be so chosen that the multiplication table takes a particularly simple form, which is in turn characteristic of the non-quaternion systems. The present paper shows that the choice of the units may be so regulated that the multiplication table becomes still simpler.—On the reduction of the general Abelian integral, by J. C. Field, embodies results (in 38 pp.) which were presented at the annual meeting of the Society held in 1897. MM. Appell and Goursat, in their "Théorie des fonctions algébriques et de leurs Intégrales" (pp. 344-345) give a brief sketch of Hermite's method for obtaining by rational operations the reduced form for a hyperelliptic integral, in which note they make a remark which seems to imply that the more general problem in the case of the Abelian integrals was still awaiting a solution. The present paper is the auth r's solution of the problem.—"Ueber flächen von constanter Gausscher Krümmung," by D. Hilbert. The greater part is concerned with Flächen von negativer and the rest with Flächen von positiver constanter Krümmung (*cf.* Dini, *Annali di Mat.* Bd. 4. 1870; Darboux, "Leçons sur la théorie générale des surfaces," Bd. 3, and Bianchi, "Lezioni di geometria differenziale").—A short note follows on the functions of the form $f(x) \equiv \phi(x) + a^1x^{n-1} + a_2x^{n-2} + \ . \ . \ . \ + a_n$ which in a given interval differ the least possible from zero, by H. F. Blichfeldt. This gives Tchebycheff's solution (from Bertrand, "Calcul differentiel," p. 512) and then the author's solution. As this gentleman has not had access to Tchebycheff's memoirs his method may not be altogether novel.

Annalen der Physik, March.—On the production and measurement of sinoidal currents, by Max Wien. The ideal electrical oscillations for use in wireless telegraphy would consist of a continuous, purely sinoidal current, the oscillation frequency of which could be varied slowly and continuously from a low figure up to frequencies that could be seen. The arrangement described in the present paper, although still far short of this, constitutes a considerable advance upon previous work, as a purely sinoidal current can be obtained with an oscillation frequency up to 8500 per second, and with a slight depar-

ture from the sine form, up to 17,000. The methods and special instruments for the exact measurement of these currents are also given.—The acoustical and electrical properties of the telephone, by Max Wien.—On the theory of rain precipitation in mountains, by F. Pockels. The conclusion is drawn from theoretical considerations that on the slope of a mountain chain there exists a zone of maximum precipitation, and that the inclination as well as the absolute height has an effect upon the amount precipitated. Both these conclusions are in agreement with observations upon the higher mountains.—The effect of current fluctuation, of electrical oscillations, and of an induced current upon a magnetic needle placed in a constant field, or upon a small soft iron inductor, by Max Hornemann.—Some results of capillarity phenomena, by A. Einstein.—On the so-called liquid crystals, by G. Tammann. It is shown that the effects produced by the so-called liquid crystals may be explained by the assumption that there is really present a mechanical mixture of two liquids. A partial separation was effected in the case of *p*-azoxyanisol.—On some experiments with the Becquerel and Röntgen rays, by F. Himstedt. The sparking distance for an influence machine is affected by both the radium rays and the Röntgen rays. The failure of Elster and Geitel to observe the latter effect is attributed by the author to the use of too small a Crookes' tube.—On the action of the Becquerel and Röntgen rays on the eye, by F. Himstedt and W. A. Nagel.—On the law of the distribution of energy in the spectrum, by Max Planck.—On the elementary quantity of matter and of electricity, by Max Planck.—Studies in hardness, by W. Voigt.—On characteristic curves in the electrical discharge through rarefied gases, by E. Riecke.—Experimental researches on the metallic reflection of electrical oscillations, by Karl F. Lindman.—On the distribution of electricity on an ellipsoid, by H. Dörrie.—On the transparency of hydrogen to light, by V. Schumann.—On the fundamental hypothesis of the kinetic theory of gases, by S. H. Burbury.—Remarks on the paper of E. v. Schweidler on the behaviour of liquid dielectrics on the passage of an electric current, by E. Warburg.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society.—Meeting held in University College, March 22.—Prof. S. P. Thompson, president, in the chair.—A paper on the expansion of silica was read by Prof. Callendar. The extreme smallness of the thermal expansion of silica (fused quartz) renders the determination of its coefficient of expansion more difficult than is the case with many substances. The author has made experiments upon a rod of pure silica 40 cms. long and 1 mm. diameter. This rod was enclosed in a platinum tube about 3 mms. diameter, which could be raised to various temperatures by the passage of a suitable electric current. Both the rod and the tube were firmly fixed at one end, and the positions of the other ends were accurately observed by a micrometer microscope reading to a thousandth of a mm. The expansion of the tube, in conjunction with a knowledge of its coefficient of expansion, served as a means of determining the temperature of the tube, and, therefore, of the rod. The increase in length, the original length and the range of temperature of the silica being known, the coefficient of expansion can be at once calculated. In some previous experiments the author has investigated the distribution of temperature along a heated platinum rod subjected to cooling at the ends. These experiments prove that the error due to end effect, in the case of the silica rod, can be neglected. The expansion of silica up to 1000° C. is regular, and is about one-seventeenth that of platinum. Between 1000° C. and 1400° C. silica expands more quickly than below 1000° C., and if left at any temperature for a considerable time continues to slowly increase in length. If a curve be plotted having temperatures as abscissæ, and increases in length as ordinates, a straight line will represent the expansion of silica up to 1000° C. Above 1000° C. the curve bends upwards, and upon cooling it returns along a path above the ascending curve, so that the final length of the bar is greater than the original length when the lower temperature is reached. The determination of the coefficient of expansion at these high temperatures was made by means of a variable zero, that is by using for the length of the rod that obtained by suddenly cooling from the higher to the lower temperature. At 1400° C. the properties of silica alter and the expansion is replaced by a contraction. On cooling from above 1400° C. to ordinary temperatures there is first an expansion and then a contraction. This property was illustrated by Prof. Callendar, the small changes in length of the rod being magnified by a lever and shown upon a screen by an optical arrangement. The critical point at which contraction occurs on heating has been found by Le Chetalier at about 800° C. His experiments were made by a differential method, using porcelain as a standard substance. As the expansion of porcelain is uncertain, the author thinks it probable that the effect noticed may be due to irregularities in the expansion of porcelain rather than in that of silica. Mr. Boys expressed his interest in the experiments and asked if the small coefficient of expansion of slate had ever been measured. The small expansion of silica would make it a useful suspension for pendulums on account of the small compensation necessary. Its perfect elastic properties might be made use of in hair springs for chronometers. Prof. Threlfall said that he had tried to measure the expansion of silica between 0° C. and 70° C. by weighing rods in distilled water, but the method was not accurate. He had made experiments similar in principle to the author's, using temperatures from 0° C. to 100° C. The devitrification of silica is troublesome, and he thought that the rate of devitrification in presence of air increased with the temperature. Dr. Donnan thought that the irregularities in the expansion of silica pointed to a complex composition. Mr. Porter (Eton) asked if the effect of fused quartz on polarised light had been investigated, and if this effect altered after heating to 1400° C. Mr. Boys said that quartz rods formed by fusion depolarised light. The chairman said that he had noticed the effect spoken of by Mr. Boys, due to strain, but he had been unable to detect any rotatory power. Prof. Callendar, in reply to Mr. Lupton, said that the expansion of quartz crystals was much larger than that of fused silica.—The spectroscopic apparatus of University College was then exhibited by Dr. Baly.—The Society then adjourned until April 26.

Chemical Society, March 7.—Dr. Perkin, vice-president, in the chair.—The following papers were read:—Nomenclature of the acid esters of unsymmetrical dicarboxylic acids, by J. J. Sudborough.—Additive compounds of α- and β-naphthylamine with trinitrobenzene derivatives, by J. J. Sudborough. The author describes a number of additive compounds of red or purple colour which are formed from derivatives of trinitrobenzene and the naphthylamines, and are more stable than such compounds as those of trinitrobenzene and aniline.—Acetylation of arylamines, by J. J. Sudborough. It is shown that the presence of ortho-substituents, whether of positive or negative character, accelerates the formation of diacetyl derivatives of primary arylamines.—Formation of amides from aldehydes, by R. H. Pickard and W. Carter. On oxidising an aldehyde with ammonium persulphate in presence of lime, a 30 to 40 per cent. yield of the amide of the corresponding acid is obtained.—A method of isolating maltose when mixed with glucose, by A. C. Hill. The author gives a method for separating maltose from a mixture of glucose and maltose based upon the fact that *Saccharomyces marxianus* destroys the former, but leaves the maltose untouched during its growth in a solution of the mixed sugars.—The vapour pressure of aqueous ammonia solutions, by E. P. Perman. The author has determined the vapour pressures of aqueous ammonia solutions between the temperatures 0° and 60°, and for concentrations up to 35 per cent.—The influence of sodium sulphate on the vapour pressure of aqueous ammonia solution, by E. P. Perman. The vapour pressure curves of aqueous ammonia containing sodium sulphate afford no indication that the latter exists as a hydrate in the solution.—Formation of aromatic compounds from ethyl glutaconate and its derivatives. The reduction of trimesic acid and the conversion of tetrahydrotrimesic acid into tetrahydroisophthalic acid, by W. T. Lawrence and W. H. Perkin, jun. Ethyl sodiodicarboxyglutaconate, $(COOEt)_2CNa.CH:C(COOEt)_2$, heated with alcohol at 150°, yields ethyl trimesate, and ethyl glutaconate, under similar conditions, is converted into a substance which on hydrolysis gives hydroxyisophthalic acid. Trimesic acid is reduced by sodium amalgam to a mixture of stereoisomeric tetrahydrotrimesic acids, of which one has been isolated in a pure state; this gives a double anhydride with acetic anhydride, which, when distilled, yields tetrahydroisophthalic anhydride.—Optical activity of certain ethers and esters, by P. A. Guye.—Halogen-substituted thiosinamines, by A. E. Dixon. The author describes a number of chloroallylthiocarbimides.—A form of tautomerism occurring amongst the thiocyanates of electro-negative radicles, by A. E. Dixon.

Geological Society, March 6.—J. J. H. Teall, V.P.R.S., president, in the chair.—Recent geological changes in Northern and Central Asia, by Prof. George Frederick Wright. The present paper is the outcome of a journey made by the author in company with Mr. Frederick B. Wright in 1900-1901. In North America an area of about 4,000,000 square miles was brought under the direct influence of Glacial ice during the Glacial epoch. The result of six weeks spent in Japan was to show that there are no signs of general glaciation in Nippon or Yesso. Neither is there any sign of glaciation along the border of the Mongolian Plateau, where the general elevation is 5000 feet, but the whole region is covered with lœss. This has usually accumulated like immense snow-drifts on the south-eastern or lee-side of the mountains, and in it houses and villages are excavated. In the mountainous region, strata of gravel and pebbles are so frequent in the loess that it is necessary to invoke both wind and water in order to explain fully the origin of the deposit. At the present time the loess in the interior is being washed away by streams much faster than it is being deposited by the wind. The journey across Manchuria from Port Arthur along the Lao-Ho and Sungari rivers was through valleys choked with alluvium, and there was no evidence that the drainage of the Amur had ever been reversed by ice, like that of the St. Lawrence; nor was there any other evidence of glaciation. The lower course of the Amur indicates subsidence. Again, there are no signs of glaciation on the Vitim Plateau. Lake Baikal appears to be of recent origin; it is 4500 feet deep and has not been filled by the great quantities of sediment brought down by the Selenga and other rivers. Although glaciers could frequently be seen on the mountains which border the Central Asiatic Plateau to the north-west, there was no evidence that the glaciers had ever deployed on the plain. The loess-region of Turkestan, and indeed the whole area from the Sea of Aral to the Black Sea, appears to have been recently elevated, in some places as much as 3000 feet. Desiccation took place at the same time, so that the larger lakes are only brackish or still fresh. Direct evidence of this in the form of deposits is given. The author thinks it likely that the absence of glaciation in Northern Asia may have been due to the rainlessness of the region, and that while America was elevated, Asia was depressed during the Glacial Epoch.—The hollow spherulites of the Yellowstone and Great Britain, by John Parkinson. A recent journey to the National Park of the United States, resulting in a study of the obsidians and rhyolites in the field and at home, suggested a direct comparison between the hollow spherulites characteristic of these rocks and those of the rhyolites of Shropshire, Jersey and elsewhere. Hypotheses framed to account for the varying structures of spherulites are: (1) Hollow spherulites are the result of some property of the original magma, or (2) are due to the decomposition of an originally solid spherulite by heated waters. Taking the second alternative first, a description is given of the effect of solfataric action on the rhyolites of the Yellowstone Cañon. The conclusion reached is "that the action of hot waters charged with silica may be to remove portions of the rock, or to permeate it without destroying its characteristic structure; that we obtain, however, no evidence to show that the spherulites are most easily attacked, but rather the reverse." Explanation, therefore, is most naturally sought in some property of the original magma, and that propounded by Prof. Iddings appears the nearest in accord with facts. Exception is taken to certain physical processes postulated by Prof. Iddings in a recent memoir, but with his earlier work the present writer is substantially in agreement. In the second part of the paper direct comparison is drawn between the structures exhibited by the hollow spherulites from Obsidian Cliff and those of examples from Shropshire, Jersey and other localities. Taking into consideration the resemblances between the hollow spherulites of the Yellowstone region and those of Great Britain, the conclusion is drawn that the hypothesis of corrosion is as inapplicable to the latter as to the former. On the contrary, the author believes that the cavities of the spherulites are the result of the hydrous state of the magma.

Royal Microscopical Society, February 20.—Mr. A. D. Michael, vice-president, in the chair.—A photograph of *Amphipleura pellucida*, taken by Mr. Brewerton, was exhibited.—Mr. Nelson said the photograph was interesting because it showed the transverse striæ as thin in comparison with the spaces between them. Some optical theorists maintained that the striæ and spaces must be of equal width, whereas he had affirmed that the striæ were much finer than the spaces. In many photographs of this object they appeared to be of equal width, but that was because the object had been badly photographed. In the example before the meeting the photograph had been properly taken, and therefore exhibited the difference in the thickness of the lines and the inter-spaces.—Mr. Rogers brought to the meeting a contrivance for exhibiting a fly in the act of feeding. This differed in some respects from Mr. Macer's arrangement for a like purpose, being a brass-plate, 3″ × 1″, underneath which a brass cone was soldered to contain the fly, the plate lying on the stage of the microscope like an ordinary slide.—Mr E. M. Nelson read a paper on the tube-length of the microscope, explaining the difference between the mechanical and optical tube-length, illustrating the subject with drawings and formulæ.—The chairman thought there was no subject connected with the technique of the microscope about which ideas were more vague than that of the tube-length; many thought it was the length of the brass tube. Although it had often been pointed out in that room that what was really meant was the optical tube-length, the subject did not seem to be very well understood, very little practical information had been published which would enable a person to ascertain the tube-length of his microscope but Mr. Nelson had now given them a method by which this could be found.—Mr. F. W. Millett's report on the recent Foraminifera of the Malay Archipelago was taken as read.—The chairman called attention to a set of slides of bacteria and blood parasites which were exhibited by Mr. Conrad Beck.—Some mounted rotifers, sent from Natal by the Hon. Thos. Kirkman, were also exhibited.

Linnean Society, March 7.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. F. Enock showed a series of lantern-slides illustrating the metamorphoses of a dragonfly, *Æschna coerulea*, and gave an interesting account of the life-history of that insect.—Mr. H. E. Smedley exhibited and made remarks on a collection of models of fungi, *Nepenthes*, *Sarracenia* and aroids, as also several models of sections of flowers, in wax and composition.—Dr. J. Murie, on behalf of Mr. H. Doubleday, exhibited an orange within an orange, the enclosed fruit having a complete rind, in which respect it differed from one previously shown by Dr. Rendle (*Proc. Linn. Soc.* 1890–91, p. 7).—Mr. Alfred O. Walker read a paper entitled "Contributions to the Malacostracan Fauna of the Mediterranean," in which he gave the results of dredging operations carried on at Cannes and Hyères from an open boat, in depths not exceeding 35 fathoms and with the simplest apparatus. The number of species obtained were as follows:—Podophthalmata, 10; Schizopoda, 8, including a new species, *Mysidopsis serraticauda*; Cumacea, 9; Pantopoda, 1; and Amphipoda, 41, including two new species, *Leucothoe platydactyla* and *Melphidipella* sp., with two others not previously recorded in the Mediterranean.—Miss G. Lister's paper on the occurrence in Egypt of *Tristicha hypnoides*, Spreng., communicated by Mr. Arthur Lister, F.R.S., was read by the secretary.

Entomological Society, March 6.—The Rev. Canon Fowler, president, in the chair. Mr. H. St. J. Donisthorpe exhibited a parasite or *Brachonid* on *Centhorhynchus sulcicollis*, bred from the galls in a turnip caused by the larva of that beetle, together with the host.—Mr. A. J. Chitty exhibited a variety of *Psylliodes cyanoptera*, Ill., the coloration of the thorax dark instead of the usual red, taken by him along with the typical form in August 1892 at Wicken Fen.—Mr. H. J. Turner exhibited a long series of *Bryophila muralis* (*glandifera*) from Dawlish. The whole were either taken on, or bred from pupæ cut out of, a single roadside wall some hundred yards long, very lofty, and facing nearly north, on which aspect, however, it was protected by higher ground. They were obtained in mid-August, with the exception of a few which emerged at intervals during September and October 1900. Generally speaking the specimens were very dark, and the series was remarkable in that it contained but a few isolated examples of the forms which are prevalent in more eastern localities like Freshwater, Eastbourne or Folkestone. The hind wings of all the specimens were dark, while in the majority the black markings of the fore wings were much intensified and increased in number, and a few specimens were largely suffused with black. A considerable number showed a dark rich green suffusion, while a large proportion were of a very deep yellow or olive colour with black markings. The yellow forms were perfectly natural, as a number emerged from the pupa exactly of that hue. Only a few showed any trace of the typical delicate

dove-colour, and it was also noteworthy that the wings had a comparatively much greater area of black scaling than the eastern forms.—On the motion of Mr. H. J. Elwes, seconded by Mr. H. Goss, it was resolved that a committee be appointed to consider the question of uniformity in nomenclature for the guidance of specialists contributing to the Victoria County Histories.—The following papers were read: Centoniidæ collected by Messrs. H. E. Andrewes and T. R. D. Bell in the Bombay Presidency, with descriptions of the new species, by Mr. O. E. Janson, and a supplementary catalogue of British Ichneumonidæ, by Mr. Claude Morley.

Mathematical Society, March 14.—Dr. Hobson, F.R.S., president, in the chair.—Prof. Elliott, F.R.S., gave an account of some algebraical identities of simple arithmetical application.—Prof. Love, F.R.S., hon. sec., gave a preliminary notice concerning the theory of stability of motion.—Papers by Prof. Burnside, F.R.S., on the composition of group characteristics, and by Mr. G. H. Hardy, on the use of Cauchy's principal values in the double limit problems of the integral calculus, were taken as read.

CAMBRIDGE.

Philosophical Society, February 18.—Sir G. G. Stokes in the chair.—On the most volatile gases of atmospheric air, by Profs. Liveing and Dewar (see p. 189, December 20, 1900, for paper on same subject read before the Royal Society).—On a method of comparing affinity-values of acids, by H. J. H. Fenton and H. O. Jones. When the hydrazone of oxalacetic acid is heated with pure water, it yields the hydrazone of pyruvic acid with evolution of carbon dioxide, but in presence of dilute acids of sufficient concentration a totally different change occurs; in this case no gas is evolved and pyrazolone carboxylic acid results. Based upon these changes, a very simple method has been devised for comparing the affinity-values of acids, and the results agree remarkably well with those obtained by the well-known methods. In order to explain the nature of the changes involved, the authors attribute the evolution of carbon dioxide to the instability of the negative ion, and they have now made further experiments in order to test this hypothesis, the results being in all cases favourable. It is further shown that it is possible by this method to compare the ionising capabilities of various solvents, and experiments have now been made with pyridine in order to throw light upon the disputed question of its behaviour in this respect.—On isomeric esters of dioxymaleic acid, by H. J. H. Fenton and J. H. Ryffel. It was shown by one of the authors on a previous occasion that the ethyl ester of dioxymaleic acid exhibits the remarkable property of becoming liquid when kept in a desiccator in presence of air, although it is relatively stable in presence of moisture or in absence of oxygen. This property has now been further investigated, and it is shown that oxidation and loss of water take place with the formation of the liquid ester of dioxytartaric acid which has the anhydrous form, *i.e.* dioxysuccinic ester. Another modification of the dioxymaleic ester has also been prepared which appears to be quite stable under the circumstances above mentioned, and it is considered probable that they represent the maleic and fumaric forms respectively.—Note on the constitution of cellulose, by H. J. H. Fenton and Miss Mildred Gostling. Certain carbohydrates, when acted upon by dry hydrogen bromide in ethereal solution at the ordinary temperature, yield an intense purple colour which was shown to be due to brom-methylpurpural. This substance has been isolated in the crystalline state, and it was further demonstrated that its production is characteristic of *ketohexoses* or of substances which give rise to these on hydrolysis. Carbohydrates of the aldose type yield none of this product. Exactly similar results have been obtained by operating in other solvents at 100°, and under the latter condition it is found that all forms of cellulose give large yields of brom-methylpurpural, and it is concluded that the results definitely indicate the existence of a ketonic nucleus in cellulose.—Some substituted ammonium compounds of the type $NR'R''R_2'''X$, by H. O. Jones. This note describes some of the compounds which have been prepared in the course of the author's work on substituted ammonium compounds in which two radicles are the same.—On the molecular weight of glycogen, by H. Jackson. The important part which glycogen plays in animal metabolism renders any experiments on its constitution interesting. The only previous attempt to determine its molecular weight was by Külz a. Bornträger, who, noting the elevation of the boiling point of water when a weighed quantity of glycogen had been dissolved in it, concluded that it had the formula $(C_6H_{10}O_5)_6$. There are many objections to the boiling point method in the case of complex carbohydrates, and so it appeared important to apply Raoult's method of the depression of the freezing point, and this is easy owing to the great solubility of glycogen in cold water. The results of a number of experiments point to glycogen having a formula between $(C_6H_{10}O_5)_{40}$ and $(C_6H_{10}O_5)_{42}$. The results are somewhat similar to those obtained by Brown and Morris (*J. C. S.* 1899) for the stable dextrin obtained by the hydrolysis of starch, and it would seem to hint that glycogen is more closely related to the dextrin than the natural starches which have much higher molecular weights.—On the condensation of formaldehyde and the formation of β-acrose, by H. Jackson. An aqueous solution of formaldehyde, obtained by boiling paraformaldehyde, was treated with basic lead carbonate and heated on a water bath for one hour. After filtering it was evaporated in vacuo at 50° and the syrup treated with a mixture of methyl and ethyl alcohols. The insoluble lead salt was separated and the alcohol distilled off from the sugar. A two per cent. aqueous solution of the sugar was heated with phenyl hydrazine acetate on the water bath for four hours. The crude osazone was boiled with water; and acrosazone (Fischer and Passmore, *Ber.* 1899) remained undissolved. The filtrate from this on cooling deposited a mass of fine yellow crystals. These were recrystallised twice again from hot water. This was found to be a mixture of osazones which have been separated by a long series of fractional precipitations.

PARIS.

Academy of Sciences, March 18.—M. Fouqué in the chair.—On the determination of latitude at sea by circum-meridian observations, by M. E. Guyou.—On the propagation of discontinuities in a viscous fluid, by M. P. Duhem.—M. Humbert was elected a member in the section of geometry, in the place of the late M. Hermite.—On the law of universal attraction, by M. H. Duport. By applying to a system of atoms the principle of least action there is obtained a generalisation of the formulæ of Mayer.—Remarks by M. Bouquet de la Grye on a work by M. P. Chevalier on the hydrography of the Upper Yang-Tse Valley.—The true value of the period of luminous variation of the planet Eros, by MM. Ch. André and M. Luizet. Two views have been put forward by astronomers who have studied this question: one representing it as a simple oscillation, always identical and reproducing itself at intervals of about 2h. 5m., the other representing the curve as being formed of two different branches, the whole of which is reproduced at intervals of about 5h. 3m. A discussion of the whole of the observed values tends to show that this latter view is the correct one, the true period being about 5h. 16m.—On the zeros of entire functions of n variables, by M. P. Cousin.—On the vibrations of beams supported at the ends, by M. Ribière.—On the entropy diagram, by M. L. Marchis. In recent years the entropy diagram has been applied by engineers to the representation of the quantities of heat given out or absorbed by the working fluid in the steam engine. In the present paper the conclusion is drawn that this application is not legitimate, and that similar difficulties arise in dealing with the gas engine.—On the propagation of discontinuities in fluids, by M. E. Jouguet.—On the action of acids upon the carbonates of the alkaline earths in presence of alcohol, by M. C. Vallée. The action of dilute sulphuric acid upon calcium carbonate is very slow in the presence of absolute alcohol, but the reaction is not a limited one, the neutralisation being complete if sufficient time is allowed.—On some cæsium compounds, by M. E. Chabrie. A description of the preparation and properties of cæsium bromide, iodide, fluoride, chromate and bichromate.—On the constituents of commercial ferrosilicons, by M. P. Lebeau. In commercial ferrosilicons three silicides are clearly made out, $SiFe_2$, SiFe and Si_2Fe, and methods are described for obtaining each of these in a pure state.—Action of the acid chlorides and anhydrides upon the organo-metallic compounds of magnesium, by MM. Tissier and Grignard. With acetyl chloride, magnesium methyl iodide gives trimethyl-carbinol, and with benzoyl chloride dimethyl-phenyl-carbinol is obtained. The anhydrides give similar products.—The action of caprylic alcohol upon its sodium derivative: synthesis of dicaprylic and tricaprylic alcohols, by M. Marcel Guerbet.—Vaporisation and hydration of ethylene-glycol, by M. de Forcrand.—Dissociation and thermal study of the compound $Al_2Cl_6, 18NH_3$, by M. E. Baud.—On direct nitration in the fatty series, by M. A. Wahl. An attempt was made to directly nitrate ethyl crotonate and tiglate,

but no true nitro-derivative could be obtained.—On the supposed binaphthylene alcohol, by M. R. Fosse. The compound described by Rousseau as a binaphthylene alcohol is a derivative of trinaphthylmethane.—On the $\beta\beta$-diacetylpropionate of ethyl, by M. F. March.—Properties of the alkyl substitution products of the ethyl ester of cyano-acetone-dicarboxylic acid. Action of cyanogen chloride upon the methyl ester of acetone-dicarboxylic acid, by M. J. Derôme.—The action of butyryl chloride upon the sodium compound of methyl acetoacetate, by MM. Bouveault and A. Bongert. Two classes of substances are produced in this reaction, there being a true carbon linkage in the one, whilst in the other the carbon atoms are joined through an oxygen atom. The separation of these isomers is described and some of their characteristic properties studied.—On the constitution of gallotannin, by M. H. Pottevin.—The production of acetyl-methyl-carbinol by the *Bacillus tartricus*, by M. L. Grimbert. By the action of this bacillus upon solutions of glucose or sugar, small quantities of the alcohol $CH_3-CO-CHOH-CH_3$ are produced. This substance, which has not been previously noted as a fermentation product, was identified by means of its osazone.—On the diagnosis of tuberculosis, by MM. Albert Robin and Maurice Binet. It is found that the respiratory exchanges are much higher in tuberculous subjects than in the healthy man, and this feature is so constant that it will be of service in the diagnosis of tuberculosis.—The slow conduction of the nerve and negative variation, by M. Aug. Charpentier.—On the opacity of the vitreous body and the rigidity of this medium of the eye, by M. A. Imbert.—On the histology of the branchia and the digestive tube, by M. P. Vignon.—On the absorption of highly diluted metallic poisons by plant cells, by M. H. Devaux. Both phanerogams and cryptogams are poisoned by solutions of lead and copper salts containing only one or two parts of the salt in ten millions of water.—Influence of darkness on the development of flowers, by M. L. Beaulaygue.—Comparative anatomy of the leaf organs in the acacias, by M. P. Ledoux.—On the tabular icebergs of the Antarctic regions, by M. Henryk Arçtowski.

CAPE TOWN.

South African Philosophical Society, February 6.—T. Stewart, vice-president, in the chair. Mr. E. H. L. Schwarz exhibited some photographs and copies of interesting Bushman paintings from Groot Riet River, near the boundary of the Ceres and Clanwilliam districts, on the road from the Cold Bokkeveld to Whupperthal. The drawings are on the face of a cliff overhanging a tributary of the Groot Riet River. There is no cave properly speaking, but the river has cut slightly into the cliff at the base, so as to form a shallow recess. The floor of the recess is some 20 feet above the present river level, and a fine Bushman pot (exhibited) was obtained here. The paintings themselves are done in a great number of styles, by different people. They are in red paint, except for three black and one brown figure. Mr. Sclater pointed out that one of the photographs evidently represented the drawing of a white rhinoceros, an animal of whose occurrence so far south no written record has been preserved.—Mr. A. W. Rogers read a paper on evidence of glacial action during the deposition of the Table Mountain sandstone.—Mr. Sclater having taken the chair, Mr. Stewart read a paper on the rainfall of the Cape Peninsula. The average for the last seven years at Signal Hill is 15·49 inches; at Rondebosch 41·22 inches; at Kenilworth 42·90 inches; at Disa Head (2500 feet above the sea) on Table Mountain 39·96 inches; and at Maclear's Beacon (3478 feet above the sea) on Table Mountain 86·81 inches. The heaviest rainfall in the Peninsula is registered at the last station. The rainfall during the month of January last was of an exceptional character, in fact there is no record of a previous rainfall during any of the summer months having approached the amount recorded.

DIARY OF SOCIETIES.

THURSDAY, MARCH 28.

ROYAL SOCIETY, at 4.30.—(1) On the Arc Spectrum of Vanadium; (2) On the Enhanced Lines visible in the Spectrum of the Chromosphere: Sir N. Lockyer, K.C.B., F.R.S., and F. E. Baxandall.—Further Observations of Nova Persei, No. 2: Sir N. Lockyer, K.C.B., F.R.S.—The Growth of Magnetism in Iron under Alternating Magnetic Force: Prof. E. Wilson.——To be read *in title only*; On the Electrical Conductivity of Air and Salt Vapours: Dr. H. A. Wilson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electrical Transmission of Power in Coal Mines: H. W. Ravenshaw.—Portable Electric Lamps: S. F. Walker.

CHEMICAL SOCIETY, at 3.—Annual General Meeting.

FRIDAY, MARCH 29.

ROYAL INSTITUTION, at 9.—Polish: Lord Rayleigh, F.R.S.

SATURDAY, MARCH 30.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 5.—Twenty-first Annual Meeting.——At 6.30.—Neolithic Implements from the North Downs: J. P. Johnson.—On Borings of the Ash-bark Beetles (*Hylesinus*): Miller Christy.—Lantern Demonstration of Colour Photography as applied to Natural Objects: E. Sanger Shepherd.

MONDAY, APRIL 1.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Effect on the Marsh Test of some Commercial Products containing Selenium and Tellurium: A. E. Berry.—A New System for the Manufacture of Borax and Nitrates: Dr. W. Newton.—Basic Superphosphate: its Preparation and Use as a Manure: John Hughes.—The Preparation of Pure Cineol from Eucalyptus Oil by means of the Arsenate: Watson Smith.—Action of Caustic Potash and Soda on Stannous Sulphide: Dr. F. Mollwo Perkin.

VICTORIA INSTITUTE, at 4.30.—The Maori's Place in History: J. Rutland.

TUESDAY, APRIL 2.

ZOOLOGICAL SOCIETY, at 8.30.—On the Myology of the Tongue of Parrots, with a Classification of the Order based upon the Structure of the Tongue: G. P. Mudge.—On the Structure of the Larynx in *Cogia* and *Balaenoptera*: Prof. W. B. Benham, F.R.S.—On a Collection of Lizards from the Malay Peninsula, made by Members of the "Skeat Expedition," 1899–1900: F. F. Laidlaw.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Burrator Works for the Water-supply of Plymouth: E. Sandeman.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Animals and Birds in their Native Haunts: Charles Reid.

WEDNESDAY, APRIL 3.

GEOLOGICAL SOCIETY, at 8.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—On the Maumené Test for Oils: C. A. Mitchell.—Some Arsenic Estimations relating to Malt Kilns: T. Fairley.—The Aeration Test for Effluents: Dr. S. Rideal.

THURSDAY, APRIL 4.

LINNEAN SOCIETY, at 8.—On some British Freshwater Rhizopods and Heliozoa: G. S. West.

CONTENTS.

THURSDAY, APRIL 4, 1901.

SPACE, ATOMS, MOLECULES AND THE ETHER.

Matter, Ether and Motion. By A. E. Dolbear, Ph.D. English edition edited by Prof. Alfred Lodge. Pp. vii+376. (London: Society for Promoting Christian Knowledge, 1899.)

La Constitution du Monde, Dynamique des Atomes. Par Madame Clemence Royer. Pp. xxii+800. (Paris: Librairie C. Reinwald, 1900.)

Mutmassungen über das Wesen der Gravitation, der Elektricitäts und der Magnetismus. Von Dr. med. Hermann Fischer. Pp. 42. (1899.)

Ueber mögliche Bewegungen möglicher Atome. Von Dr. med. Hermann Fischer. Pp. 92. (Dresden: Hellmuth Henkler, 1900.)

A QUARTER of a century ago the Society for Promoting Christian Knowledge published a small book of 125 pages on "Matter and Motion," by Prof. Clerk Maxwell, and it is interesting to reflect that the necessity of adding the ether to the title of a new book issued by the same publishers is largely due to the important modern developments of the ideas which, in his more abstruse writings, the author of the original book suggested. There is, no doubt, a considerable demand at the present time for a book dealing in a popular way with general notions about molecules and the ether; but it is desirable that, in attempting to meet this demand, scientific accuracy no less than simple and popular treatment should be aimed at.

Dr. Dolbear is fortunate in having it stated conspicuously that his book is "edited by Prof. Lodge," who in his preface remarks that

"the luminous manner in which the author deals with the great problems as to the nature of electricity, magnetism and the kinetic relations between ether and matter will make this book interesting and instructive to a wide circle of readers."

But even the editor is bound to admit that

"I do not agree with all the author's statements, particularly that on p. 75, where he maintains that transfers of energy are always from bodies having higher rates of motion to those having lower rates. . . ."

An examination of the book shows that it contains many statements quite as open to objection as that cited by Prof. Alfred Lodge. A few extracts will give an idea of the style of the book.

On pp. 14–17 the author takes a great deal of trouble to prove that we shall never be able to construct a microscope sufficiently powerful to see individual molecules. To prove this, he tries first to argue from a rather far-fetched analogy between the powers of the microscope and the stage-coach and the railway; then he refers to the impossibility of seeing molecules owing to their rapid motions; and finally he states that

"there is every reason to believe that the molecules of all bodies are so perfectly transparent that they could no more be seen than the air, even if there were no difficulty from their smallness and their motions."

It would be more correct to refer to p. 149 and to point out that the limits of microscopic vision are defined by the wave-length of light.

On pp. 48–49, speaking of different kinds of motion, we are told:

"For instance, a compound of a free path motion with a vibratory motion will give a wave or sinuous motion if the direction of vibration be at right angles to the free path."

A little further down, on p. 49, the author says:

"Indeed, we know that some sorts of motion are propagated in the ether. For instance, what we call light is an example. Its form is *undulatory;* and as we have seen an undulatory motion is a compound of a re ctilinear and a vibratory. . . ."

While seven lines lower down he says:

"I am not aware that any simple rectilinear motion is known to occur in the ether; there may be, and likely enough is, such."

In speaking of non-Euclidean geometry, he suggests a rather curious idea of the relations between men of science of different countries:

"This new geometry I have alluded to has been worked at by the best mathematicians of all civilised nations, and they agree in their conclusions. They certainly would not do so if there were the slightest apparent reason for rejecting them; for national jealousies are too strong, and a sense of the value of truth too great, to allow any such notions to gain currency anywhere if there were any possibilities of breaking them down."

Here is how the author defines mass, on p. 61:

"It has become necessary to find some measure for matter that shall be independent of position, and this has been found by dividing the weight of a body at a given place by the value of gravity at that place and calling the quotient the mass, so that if w represents the weight of the body at a given place and g the value of gravity at the same place, that is the velocity per second that gravity will give to a body if left free to fall, then $w/g = m$, the mass."

This definition is calculated to make any reader think that the mass of a body weighing 1 lb. is 1/32·091 at the equator and 1/32·255 at the poles. How is such an inference to be reconciled with the statement that it is "independent of position"?

Further on (p. 346) we have another definition of mass:

"Mass as a property of matter is generally defined as the amount of matter considered, and is measured by what is called acceleration, that is, the velocity it acquires in a second when acted on by a constant force or push."

On p. 106 we have the following definition of temperature:

"The word 'temperature' is used to denote the degree of heat there may be in a unit volume of the substance. . . ."

According to this, calorimetry would be made easy, for (*e.g.*) a cubic foot of lead and a cubic foot of air at the same temperature should contain the same "degree of heat"! As a final sample, we quote the author's explanation of the heating of a gas by compression on p. 322:

"When a gas is condensed by pressure the individual molecules have less free space to move in, and they consequently collide with each other more frequently. Being

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elastic their average amplitude of vibration is increased proportionally, and a greater number of them will strike with greater velocity upon the walls of the containing vessel per second than before. Thus the temperature and the pressure of the gas are increased. We say that mechanical energy has been converted into heat energy, or sometimes simply into heat, though what has really happened has been the transformation of external translational motion into internal vibratory motion, which the elasticity and mobility of the molecules permit. When by friction or percussion a body is heated, the same thing precisely has happened; translatory motion has been transformed into vibratory, through the agency of the molecules, which have, therefore, acted as machines for transformation."

Madame Royer has produced a volume of 800 pages, in which she has endeavoured to expose fallacies in the existing theories of matter and to formulate a new theory of her own. The book is illustrated by coloured plates and pretty pictures of molecules built up of atoms. It deals in turn with the history of theories of matter, properties of atoms, vibratory phenomena (including heat, light, sound, smell and taste), solid bodies, liquids and gases, vital processes, gravity, theory of the tides and cosmic evolution.

Madame Royer seems to believe that atoms are fluids in their nature (the indivisibility of atoms has long been a thing of the past) and that there are three states of the cosmic substances, namely, the initial or ethereal state, in which the atoms are without mass and preserve the properties of perfect fluids; the material state, in which the atoms only possess a variable finite portion of their initial expansive substance and all their fluid properties are attenuated; and the vitaliferous state, in which the atoms are not subjected to the laws of inertia and gravity, but can overcome these in producing automatic movements. No such thing as attraction is supposed to exist, but the fluid atoms are held together by an ethereal pressure; they would be spherical when isolated, but when formed into molecules they become compressed into polyhedral forms. The authoress takes exception to the accepted theory that quantity of matter is synonymous with mass; but does not this mainly depend on what we define to be *matter*?

The explanation of gravity attributes this phenomenon to pulsating pressures in the ether—an idea by no means novel, the hydrodynamical theory of pulsating spheres being well known. How far Madame Royer has worked on old lines, and how far she has invented a new theory, it is not our present purpose to examine. We cannot discover anything very remarkable in her new theory of the tides, the principal point of which appears to be that it is necessary to discuss the tides in the earth and the atmosphere as well as in the sea.

It may be convenient here to state roughly in an abridged form the fundamental assumptions stated on pp. 68–70:

"(1) The primary elements of cosmic matter are volumes of fluid, which tend to expand by reason of their internal activity, but are kept from so doing by external and mutual pressures. (2) The cosmic elements constituted by centres of emission of an indefinitely expansive substance are active, and repel one another according to the law of the inverse square. (3) Ponderable bodies are constituted of elements in which the expansive forces are attenuated, and their inertia is inversely proportional to the radius of their virtual sphere. (4) The masses of ponderable bodies are equal to the sums of the inertiæ of their elements, and vary directly as their number and inversely as the cube roots of their expansive forces. (5) The variations of volume of complex bodies under changes of pressure and temperature are the result of correlative variations in volume of their elements, which remain always in contact and are bounded by planes of mutual intersection. [Is it certain that the boundaries are always plane?] (6) It follows that the universe is absolutely filled [with a medium, of course] under constant average pressure, and the local and temporary variations of pressure are the cause of all motion."

The book is evidently the outcome of many years of thought and study on the part of its writer, and it would be of little use to express a single opinion, favourable or unfavourable, on it in a review. Some of the ideas give one the idea that there is much to be said in their favour. The suggestion that what we call atoms may be represented better by portions of fluid than by solid bodies is, whether tenable or untenable, certainly worth careful consideration, and should, if new, certainly be labelled and consigned to its proper place in the storehouse of accumulated thought which is being built up under the general title of "theories of matter." But is it new?

Dr. Fischer, in his first paper, takes as his starting point Korn's theory, according to which gravitation and electricity are referred to a periodical pressure to which the whole solar system is exposed. He considers, however, that it is not necessary to go outside the solar system to find an explanation of the phenomena, but that they can be explained very well by certain ordered motions within the system itself. He assumes the existence of two kinds of atoms, namely, the atoms of chemical elements and those of the ether. The majority of element-atoms are supposed to be elongated, those of the ether being spherical, of average equal size and practically of the nature of mathematical points.

"Possible motions of possible atoms" is an inviting title for his second paper. Its sections deal with space and time, matter and force, the chemical atoms, the ether atoms, the motion of chemical atoms and molecules, and cosmogony. In summing up, Dr. Fischer arrives at the following conclusions:—(1) Discrete deformable active atoms can only be of approximately spherical shape, never with sharp corners or edges; (2) Element-atoms of the most varied forms can be built up of such discrete atoms; (3) Owing to their activity atoms can move, and every motion is due to some force acting on matter; motion is only produced by leaps or bounds, after which it remains constant in magnitude and direction, and can only increase and decrease by jerks. A curvilinear motion is to be regarded as made up of a series of elementary rectilinear motions; (4) Elastic stresses presuppose deformable active atoms; (5) After elastic repulsions, deformable active atoms of certain dimensions may either designedly come into contact or separate; (6) With regard to oscillatory motions, approximately spherical atoms move uniformly, while element-atoms and molecules, especially those of elongated form, can either be turned about their axes or they can perform elliptic or circular oscillations made up of elements of rectilinear motion in directions along, perpendicular to, or inclined to their

axes; or the parts of a molecule may oscillate about their common centre of mass; (7) All oscillations are either ordered or unordered motions.

The various types of oscillation are held by Dr. Fischer to account respectively for chemical light-vibrations, electric light-vibrations, heat, gravity, electric and magnetic phenomena.

While Madame Royer's speculations on the nature of things lead her to think that the laws of nature are never disturbed by "that imaginary being called God, who has no place in an autonomous universe," Dr. Fischer concludes his paper with the quotation

"Die Himmel erzählen des Ewigen Ehre."

We far prefer the spirit of the latter writer, who in the course of his work clearly sees that theories of matter can but be approximate mechanical representations of the truth. It is true that a good deal of progress has been made of late years in the conception of elements and media which reproduce more or less closely the physical phenomena known to us; but whether we regard the universe as filled with a single medium and atoms as singularities occurring in it, or regard everything, including the ether, as built up of discrete atoms, a reduction of the number of varieties of atoms and media is not necessarily synonymous with an advance in physical theory. What is rather wanted is to reduce to their minimum the number of fundamental hypotheses required for the mathematical deduction of the physical phenomena known to us. This was the spirit which actuated Maxwell, and while since his time we have become more and more familiar with molecules and the ether, it is doubtful whether our advances in reducing their properties to mathematical formulæ have been so great as they ought to be. With the exception of Larmor, there are few physicists now carrying on the work of Maxwell, and there is, unfortunately, a growing school who conceal their ignorance of the causes of things by referring everything to "molecules" or "the ether," and endowing these with new properties without troubling much if such properties are reconcilable with those previously attributed to them. What is equally important, as our theories of matter advance, fresh properties become known to us, so that as soon as we have climbed to the summit of one hill, we see a still higher one ahead. G. H. B.

ALLEGED HYPOSTOMIAL EYES IN THE TRILOBITES.

Researches on the Visual Organs of the Trilobites. By G. Lindström. Kg. Svn. Vet. Akad. Handlg., Stockholm. Bd. 34, No. 8. Pp. 74; 6 plates. (1901.)

THIS memoir of 74 pp., illustrated by six most beautiful plates, deals in reality with the joint labours of the author whose name appears upon the title-page and his talented assistant, G. Liljevall, to whom the first detection of the central fact of the presence of supposed eyes on the labrum (hypostome), the labour of cleaning and preparing the specimens described, and, above all, of making the original drawings (for which no praise can be too high) are due. The material described is mostly a rich collection preserved in the Swedish National Museum; but it is explained, with comment none too flattering, that "collections of foreign species and the waste (vast) European and American literature" have been taken into account. The work opens with a short introduction, dealing mainly with the detailed surface anatomy of the hypostome and the orientation of the supposed hypostomial eyes, or "maculæ," as the authors name them, together with an account of the first observations upon which, by comparison with the cephalic eyes of the compound type, they were led to regard the maculæ of the facetted kind as visual in function. There then follows a chapter upon the blind Trilobites. A detailed dissertation upon the origin and nature of the ridge hitherto designated the "eye-lobe," "ocular fillet," or "Augen Leiste," and known by a variety of other names, next follows; and the authors, finding that "in a long series of genera succeeding each other it has no connection whatever with any eye," prefer to term it the "facial ridge"; and they subdivide the blind species into series characterised by its presence or absence.

In the foregoing section much is made of the young larvæ of Olenellus, discovered by Ford and Walcott, as furnishing a clue to the development of this facial ridge, and of the fact that during the growth process of the higher forms the pygidium follows the head region in order of appearance, and that the intervening "thorax" or body-segments are intercalary in origin. Passing to detail concerning the head, Bernard's terms, "rhachis" and "pleura" are preferably employed, and in dealing with its anatomy a passing compliment is paid to the Japanese embryologist, Kishinouye. Attention is next drawn to an important series of growth stages of Liostracus, described by Brögger in 1875, but generally overlooked, and from the study of these the conclusion is reached that the developmental changes of the head segments in the higher Cambrian and Silurian forms are of a different order to those of the Olenellidæ and Paradoxidæ, which Dr. Lindström would apparently regard as representative members of distinct series; and the final result is arrived at that the earliest oculate genus was Eurycare of the Olenellus schists, and that Olenus and Parabolina were probably blind.

The succeeding section is devoted to the consideration of the eyes of the Trilobites, the detailed structure of which the authors, with immense labour, have investigated, by sections taken at various planes and by other means at their disposal. They have been thus enabled to distinguish four types of cephalic eye, which they believe to have probably succeeded one another in the following order, viz. the simplest or Harpes type, of simple ocelli; the Eurycarid, biconvex or lentiform type; the Megalaspid or prismatic type; and the Phacopsid or "aggregate" type—each of which is duly figured with as much detail as is forthcoming, and in section as observed for thirty-six species. Further detail under this head is impossible in these pages; and we pass at once to the fuller consideration of the "maculæ," or hypostomial eyes so-called.

Although the authors record these organs for some 136 species of thirty-nine genera, they state at the outset that the genera in which they have found them lens-bearing are relatively few, and that the lenses or "granules," even where recognisable, have been found to be present only

over the lower third of the macula, with the exception of the Asaphidæ, Illænus and Lichas, of which they remark the entire macula shows "the structure which characterises" it as a visual organ. Beyond this, the macula, for which an average diameter of 0·99 mm. is given, is described as "oblong or ellipsoidal, and for two-thirds of its surface perfectly smooth or rather glossy," and its "granules" or lenses are estimated to be but 0·055 mm. in diameter at their largest.

With the maculæ, as with the cephalic eyes, a wide range of modification is recognisable, which, if the authors' assumption of a visual function for the former be correct, leaves little doubt that the facetted type is for it a culminating one. They state that the maculæ, "whether they show any organic structure or not," have commonly an "excessive thinness of their shell," and in so far as they enter into comparison with other Crustacea, while they call attention to the similarity "in the formation of the superior surface of the head in the Trilobites and the embryos and newly-hatched larvæ of Limulus," they incline to the belief that, concerning the cephalic eyes, Limulus "stands completely isolated amongst all Arthropods," except for a certain resemblance between its cornea and that of Peltura." They similarly deny resemblance to the Phyllopods, and regard "the eyes of the Trilobites" as showing "the greatest conformity with those of the recent Isopods."

Full perusal of the details which they attribute to the hypostomial macula shows them to have discovered an interesting and important organ. Comparison is instituted between it and a thin area of the hypostome of the living Apus; but, if sound, there is not much to be said from this standpoint for the "eye" theory in any but the facetted forms. For the types which remain, the study of the remarkable details described in the memoir leaves us in doubt as to the evidence for the supposed visual function. Convinced of its actuality, however, in an attempt to bring the living Crustacea into line, the authors fall back upon the fact that in the embryo Limulus the median eyes have been described by Packard and others as originally ventral, and that there have been recorded for the Lepadidæ two ventro-lateral eyes in an adult by Darwin, two ventro-lateral and a ventro-median one in a larva by Claparede, and similar indications by Hesse and Spence Bate.

Remarking upon the supposed habits of the Trilobites, of which we know nothing very definite beyond that a burrowing habit has been suggested, our authors express themselves averse to the popular idea that they "lived in abyssal depths . . . where the most intensive darkness prevailed." There are, however, considerations arising out of recent discovery concerning these animals worthy of note in this association. Owing to the wonderful conditions for preservation which characterise the Utica slate deposits near Rome, N.Y., certain Trilobites, during the last six to seven years there unearthed, as all zoologists are well aware, in the hands of Dr. Beecher, of Yale College, Conn., have yielded results of importance second to none in the palæontology of the period. The proof that but one pair of antennæ were alone present, and that they were uniramous, brings the adult Triarthrus at once into line with the Nauplius larva, as distinct from all other known Crustacean forms; while that of a simple uniformly jointed condition of the post-oral appendages, most, at least, of which were biramous, and of the Phyllopodan tendency of those posterior and last developed, more than fulfils the highest expectations of the philosophic morphologist, and amply justifies our trust in the larval form. One conspicuous feature of these appendages is the recurrent development from each of an inwardly directed and tapering gnathobase, most assuredly concerned with its fellows in the seizure of the prey and, by transfer of this from limb to limb, with its passage to the mouth. We know nothing of the habits of these animals as they swam, but from this feature the possibility is suggested that, like the living Apus, they may have swum upon their backs; and, if so, the presence of hypostomial eyes would become the more readily intelligible. On the other hand, the possibility that the "maculæ" may have been luminous organs must not be overlooked; and bearing upon this surmise, it is well to remember that such organs are known to exist in a lenticulate and aggregated form, and that the probable presence of one of simple type in a sponge, taken in conjunction with the extent to which like organs are functional as a lure to the prey, would dispose of any anomaly in their possession by blind animals. And finally, inasmuch as the remarkable organs present in the Chitons, some of which, being lens-bearing, were by Moseley described as eyes, so far as experiment with light has yet progressed, have given but negative results, it becomes a question whether, until we know more concerning even these, the term "æsthete" may not be well extended to them all. Arguing by analogy from these to the Trilobite "maculæ," it must be admitted that their visual function is not proved.

In the further inquiry into the nature of these remarkable organs there lies a most promising field. As we cannot experiment with them, we provisionally retain an open mind concerning their functions; and while we are profoundly grateful to our authors for their intensely interesting memoir and the great labour they have bestowed upon it, we shall await with much interest the further results of their inquiry.

G. B. H.

THE RELATIONS OF THE OSTRICH-LIKE BIRDS.

On the Morphology and Phylogeny of the Palaeognathae (Ratitae and Crypturi) and Neognathae (Carinatae). By W. P. Pycraft. *Trans.* Zool. Soc. London, vol. xv. pp. 149–290, pls. xlii–xlv.

THE relation of the flightless ostrich-like birds (Mr. Pycraft says we must no longer call them Ratitæ) to more typical representatives of the class Aves has long been one of the puzzles of ornithology, and it is therefore a matter for satisfaction that the author of this important memoir has undertaken the task of revising and extending our knowledge of the anatomy of the existing members of the former group. The work was undertaken in connection with Mr. Walter Rothschild's revision of the cassowaries, of which, indeed, it forms the sequel; and the thorough manner in which it has been carried out forms a model of what such researches should be, and enables zoologists to draw their own conclusions on the questions at issue, if they are unable to accept all those at which the author arrives.

For a long time ornithologists have been hesitating whether or no to include the tinamus of South America in the same group as the ostrich-like birds; but this hesitating spirit does not commend itself to Mr. Pycraft, who boldly says that the affinities between the two imperatively forbid their separation. And it is this innovation which leads him to reject the time-honoured title, Ratitæ.

The inclusion of the tinamus in the group renders it necessary to assume (even if we had not to do so on other grounds) that the ancestors of the ostrich and its kindred were formerly endowed with the power of flight. Further, the author regards the group as a convergent one, which has had a multiple origin from the common avian stem before this began to split up into the more specialised "Carinate" types. The cassowaries and emeus are regarded as representing the most primitive branch, which culminated, perhaps, in the more advanced ostrich. From this it apparently follows, although it is not stated in so many words by the author, that the divergence of the Ratites (to call them by their old name), including the tinamus, took place while birds still retained teeth. While this may be so, it must be confessed that some palæontological evidence in its favour would be most welcome.

It may be added that, according to the genealogical tree given by Mr. Pycraft, the loss of the teeth in birds must have taken place at a still later epoch, for we find the cretaceous Ichthyornis branching off long after the divers and ducks had been differentiated. This seemingly implies that the origin of the latter is to be carried back to the Jurassic epoch, when, so far as we yet know, Archæopteryx was the sole representative of bird life. The author promises a supplementary memoir on Apteryx, where he will, perhaps, explain how we are to get out of this difficulty.

A slight discrepancy between the aforesaid "tree" and the text likewise stands in need of explanation. On p. 264 of the latter it is stated that the ostrich-like birds "are to be regarded as polyphyletic—probably triphyletic," and yet in the "tree" we find them arising from five distinct branches.

Space does not allow of allusion to the many interesting observations on the osteology and pterylosis of the group recorded by Mr. Pycraft, but these really form a storehouse of information of the utmost value to future workers. As he himself would doubtless be one of the first to allow, opinions may legitimately differ in regard to many of the conclusions arrived at by the author, but as to the value of his investigations all opinion must be in accord. R. L.

OUR BOOK SHELF.

Researches on the Past and Present History of the Earth's Atmosphere. By Dr. T. L. Phipson. Pp. xii + 194. (London: Charles Griffin and Co., Ltd., 1901.)

IN style and scope, Dr. Phipson's book reminds us of essays submitted to the Smithsonian Institution for the Hodgkins Fund Prize, and afterwards published in the Smithsonian Report. A more or less popular description is given of the atmosphere in its various relationships to man, and in its meteorological aspects; while in many places short statements are made of observations and investigations carried out by the author himself. The book should thus prove of interest to general readers as well as to meteorologists and other students of science.

In the early chapters, the thesis which Dr. Phipson seeks to establish is "that the primitive atmosphere of the earth was nitrogen, into which volcanic action poured more or less carbonic acid and vapour, and that after vegetable life appeared, free oxygen made its appearance in the air, and has increased in quantity from those primitive times to the present day." In connection with the subject of the variations in the amount of carbon dioxide in the air, it might have been well to refer to the work of Arrhenius, Chamberlin and others on the effect of variations in the proportion of the gas in air upon the mean annual temperature, and past geological conditions.

Dr. Phipson regards argon as allotropic nitrogen or a carbide of nitrogen. The hydrogen gas driven off from meteorites when heated is, he holds, produced by the decomposition of water vapour by the meteorite during the passage through the air, or the absorption of water, the oxygen of which combines with some of the constituents of the meteorite when it is heated, thus setting hydrogen free. He refers to the variation in brightness of the star Algol as "still a mystery to astronomers," though the spectroscopic work of Vogel has placed the cause of variability almost beyond doubt. Like many other writers who have not followed closely the physical geography of recent years, Dr. Phipson believes in the Gulf Stream myth, going so far as to commit himself to the statement that "The mild climate of the British Isles is very greatly due to this immense current of warm water, without which we should be no better off, in this respect, than people who live in the Arctic circle." To understand how unfounded this statement is, we refer the author to a paper in the U.S. *Monthly Weather Review* of September 1900.

In a short chapter on meteorites the remark is made, "They are, no doubt, of the same composition as the moon; and are, I believe, minute satellites of our earth, thrown off like our larger satellite was thrown off, in the earliest stages of its existence." Here again we have statements with little evidence to support them. Nothing is known of the exact composition of the moon, so the words "no doubt" in the sentence quoted are, to say the least, gratuitous.

While, therefore, we think the book contains an interesting account of the earth's atmosphere, we suggest that in several places statements are made as if they were accepted conclusions, whereas they are often opposed to the opinions of competent authorities.

Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History). The Jurassic Flora. I. The Yorkshire Coast. By A. C. Seward, F.R.S. Pp. xii + 341; plates xxi. (London: British Museum (Natural History), 1900.)

FOSSIL plants from Gristhorpe Bay and neighbouring parts of the Yorkshire coast are so widely distributed among museum collections that Mr. Seward's descriptive catalogue of them will be welcomed by many museum curators in Britain and on the continent. But the volume is more than a catalogue; it is a history of Oolitic plant-remains of Yorkshire, exemplified by the fine series preserved in the British Museum. In addition to the data provided by this material, the descriptions are based upon specimens in many other collections which have been examined and considered. As might have been expected, the identification of type-specimens was a difficult task, and in many cases it has been found impossible to specify the type, which fact, remarks Mr. Seward, "has afforded a practical demonstration of the need of some system for the centralisation and cataloguing of all specimens which have served for the diagnosis or illustration of new species."

In an introduction a brief historical survey is given of our knowledge of the Jurassic plants of Yorkshire, and also of the Jurassic plant-bearing strata of France, Germany and other countries which resemble those of the Yorkshire coast.

In the descriptive part of the catalogue the specimens are grouped, so far as possible, in accordance with their natural affinities. Fifty-five species are described, and are distributed as follows:—Bryophyta, 1; Equisetales, 2; Filices, 20; Cycadales, 23; Coniferæ, 9. There is a resemblance between this flora and the Wealden flora, among the common characteristics being the absence of Angiosperms and abundance of Cycads and Ferns.

In conclusion, Mr. Seward remarks: "It is in the southern tropics that we must look for existing forms which afford the most striking links between the vegetation of to-day and that which has left imperfect records in the Jurassic sediments of the Yorkshire coast. The climate was presumably more tropical than that of North Europe at the present day; there is no evidence that the plants of Jurassic times grew under conditions which induced xerophytic characters, moisture being probably abundant and favourable to the luxuriant growth of Equisetums and Ferns."

Practical Electrical Testing in Physics and Electrical Engineering. By G. D. A. Parr. Pp. vi + 392. (London: Longmans and Co., 1901.) Price 8*s.* 6*d.*

Mr. Parr is head of the electrical engineering department of Yorkshire College, Leeds, and the book before us represents the instructions and experiments given to students in the practical course in that department. It is not our object to criticise that course, the value of which must largely depend on the theoretical teaching accompanying it; suffice it to say that it is apparently modelled very closely on that given by Prof. Ayrton at the Central Technical College. Whether there is sufficient justification for the publication of Mr. Parr's book must depend on whether the details of the system and apparatus are sufficiently widespread; in the majority of cases the instructions given for each experiment imply the provision of special apparatus for carrying out the test, and the instructions are given, if we may use the phrase, in terms of that apparatus. A more general description of the experiments would be of wider use, though probably not so convenient for the student actually passing through Mr. Parr's course. There is a good appendix describing the chief instruments and apparatus used, and another appendix giving solutions of the various problems raised by the experiments which we do not think so valuable, except as a labour-saving device to the demonstrator or idle student. The experiments are, on the whole, well devised to bring out clearly the fundamental laws of electricity and magnetism. We are sorry, however, to see included an experiment to "prove" Ohm's law, in which P.D. is measured by a high-resistance galvanometer; a galvanometer can only be employed to measure P.D. if Ohm's law be true, so that it cannot logically be used for this purpose in an experiment to prove the law. The method given second by Mr. Parr, in which an electrometer is used to measure P.D., is the only satisfactory one for proving Ohm's law. Technical teachers who are seeking to develop a practical course will find this volume a valuable guide.

LETTERS TO THE EDITOR.

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Audibility of the Sound of Firing on February 1.

It is an interesting question how far the accounts of various observers as to the sound of the minute guns on February 1 having been distinctly heard at many distant stations and not heard at others comparatively near by attentive listeners, and as to the character and duration of the sound, can be explained by known laws of the propagation of sound in the atmosphere. To this question I should like here to offer such answer as I have been able to arrive at after careful consideration and some rough calculation.

The firing line extended from the *Majestic* at the eastern end to the *Alexandra* at the western, in a direction some 6° N. of W. for about 8 miles. The eastern half was a double line of 16 pairs of ships, the distance between the two lines being about ¼ mile, nearly the same as that between the successive ships in each line (2½ cables or ¼ sea mile); while the western half was a single line of 14 ships.

Some stress has been laid by observers near the firing line on the want of simultaneity in the discharges from the different ships. There is doubtless need of more accurate information on this point, but I cannot help thinking Mr. Hinks's estimate that, as "the firing ran down the double line, the interval between the successive pairs of flashes was about half a second," is excessive. This would add, to an observer at Southsea, 8 seconds over and above the 19 to 20 seconds by which the sound of the westernmost pair of the double line was necessarily behind

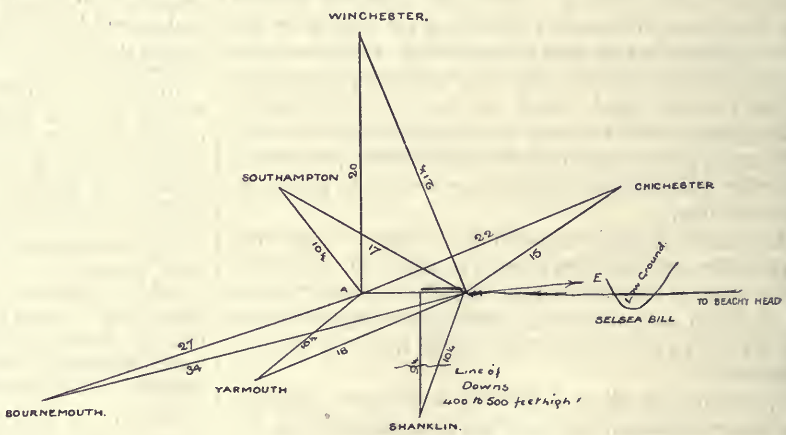

Fig. 1.

that of the first pair, whereas he says that the whole sound "lasted only about 20 seconds." I do not think, therefore, in the absence of more exact information, account need be taken in a general explanation of the supposed want of simultaneity, which I estimated on such information as I could get as not amounting to a difference of more than 2 or 3 seconds.

Mr. Hinks's observation is in another respect important, as it would seem to show that the second half of the firing line was unheard at the distance of 4 to 5 miles from its eastern end.

The known causes which would or might affect the audibility of the sound impulses arriving at any station are, I think, these: the position of the station relatively to the firing line, the direction of the wind and the variation in its speed with the height above the earth's surface, the variation in temperature of the different strata of the atmosphere, and for greater distances the curvature of the earth's surface.

Of these, for distances not exceeding 30 to 35 miles from the firing line, I believe the dominant factor to be the first, that is, relative position of the station.

The accompanying diagram (Fig. 1), drawn roughly to scale, shows this, I think, conclusively.

At Shanklin the reports were heard, but they were not very

loud or at all comparable with such as are heard there (and felt too) when gunnery practice with big guns is going on near Portsmouth. This is what might have been expected, since the nearest distance from the firing line was $9\frac{1}{2}$ miles from a point close to the west end of the double line of ships, and the distance from its extremities about $10\frac{1}{4}$ miles. Hence the sound impulses from the whole line arrived within the interval required by sound to travel $\frac{3}{4}$ of a mile, or about $3\frac{1}{2}$ seconds, and thus concentrated were audible, although a line of downs 400 to 500 feet high intervened at a distance from Shanklin of about 4 miles.

At Yarmouth a gentleman, who went on to the pier specially to listen, heard "not a single gun." This is explained by the fact that he was so near the prolongation of the firing line westward that, though only $10\frac{1}{2}$ miles from the western end, he was 18 miles from the eastern extremity, and so the sound impulses, spread over an interval corresponding to $7\frac{1}{2}$ miles, or about 36 seconds, must have arrived at intervals of a little more than a second as separate sounds from the successive ships, each by itself too feeble to be audible.

The same explanation holds for Bournemouth west and a little south of the prolongation, and for Chichester east and a little north of the same, where the sounds were not heard, the impulses being spread over an interval of about $33\frac{1}{2}$ seconds.

Winchester is 20 miles nearly due north from the western end of the firing line, and its distance from the eastern end is about $21\frac{1}{2}$ miles. The difference of $1\frac{1}{2}$ miles corresponding to about 7 seconds might perhaps have been expected to have produced sufficient concentration to make the reports audible, but they were not heard, and probably this is partly due to the intervention of the downs at the foot of which Winchester lies.

As to Southampton I have no information, but as it corresponds in position to the N. of the line almost exactly to Yarmouth on the S., there can be little doubt but that there too the firing was inaudible.

Thus far an explanation founded on the supposition of a still atmosphere of uniform temperature appears to be sufficient. But we have good evidence of the reports having been distinctly heard at distances of sixty, seventy, and even to seventy-five miles from Portsmouth in directions varying, from the eastern prolongation of the firing line, northwards through north-east to due north; but, so far as I know, not west of the north line. For these, at any rate for stations not far from the prolongation of the firing line, some totally different explanation must be found, and the first step must be to consider the effect of the wind.

Prof. Sir G. Stokes first pointed out in 1857 that, if the speed of the wind increases with the height above the earth's surface, the path of a sound ray cannot be straight, but must be curved and bent *downwards* towards the surface for rays *in the direction* of the wind, but *upwards against* the wind.

Now on February 1 there was a steady gentle wind, estimated at somewhere about five miles an hour, from the west with a cloudless sky, and no *visible* irregularities of cloud or fog to interfere with the normal propagation of sound. Hence for places west of the firing line the sound rays, on Stokes's principle, were diverted upwards into the upper atmosphere, and so passed over the heads of places at even moderate distances, so that no sound reached them. For places east of the same the contrary effect was produced, and closer examination is necessary to trace the consequences.

Proceeding from Stokes's principle, it is shown in Lord Rayleigh's "Treatise on Sound," ch. xiv., that on the hypothesis of the speed of the wind increasing upwards from the surface in direct proportion to the height, the path of a ray of sound advancing with the wind would be a catenary whose axis is vertical and directed downwards from its vertex, so that the ray, after ascending in its curved path to the vertex, would descend in a similar path again to the horizontal line through the point whence it started. Thus a ray starting from A (Fig. 2) in the direction AT would reach B in the horizontal line through A by the path ACB of the catenary, whose vertex is C, midway between A and B; and hence all the sound energy, which in air with no differential motion of its strata would have been spread over the circular sector TAB, must be concentrated between the curve ACB and the horizontal base AB. Now the angle TAB, when not large, is very nearly proportional to the distance AB, and hence in a vertical plane the concentration of the energy is proportional to the distance AB. On the other hand, in the horizontal plane the energy is spread out in azimuth proportionally to the distance AB, and thus the concentration in the vertical plane is balanced by the spread in the horizontal plane, so that the sound energy reaching two observers at different distances from A in the horizontal line AB would be about the same in amount.

There is, however, this difference, that, as the distance AB is greater, the difference in length between the curved path ACB and the direct line AB is greater, and this produces a greater retardation in time between the extreme curved ray and the horizontal ray, so that, the same energy being received in a longer time, the impression on the ear at a distant station would be enfeebled as compared with a nearer one.

Assuming this general reasoning to be correct, I have endeavoured to apply it quantitatively to the case of Eastbourne, or rather Beachy Head, for which we have the valuable observations of your correspondent, "H. D. G."

The firing line extended eastward passes directly to Beachy Head over a sea surface, with the exception of about two miles across the low peninsula of Selsea Bill. I have assumed the direction of the wind to coincide with this line, as it approximately did, and, farther, in the absence of definite data as to the rate at which the wind speed increased upwards, I have assumed it to amount to five miles per second for each mile of vertical height. I find then that at the distance of sixty miles from any firing point, which is about the distance of Beachy Head from Spithead, all sound rays starting at a less elevation above the horizon than about 11° 23′ would be bent round to the horizon between these two points, the extreme ray having reached an elevation of just over three miles; and the length of its path exceeding the direct horizontal distance by about four-tenths of a mile, it follows, from the known speed of sound, that the sound energy from a single gun would be at Beachy Head spread over an interval of very nearly two seconds. I conclude, therefore, that no single gun or pair of guns could have

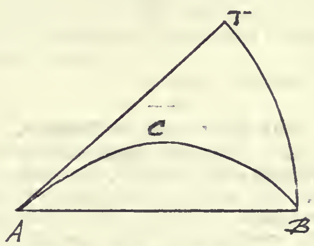

FIG. 2.

been heard there. But since the interval along the line between successive ships or pairs of ships corresponds only to a sound interval of just over one second, the sound impulses from successive ships would overlap (as they would not do at smaller distances, such as Chichester), and might so reinforce one another as to become audible. Doubtless the reflections of rays from the smooth sea surface would also contribute to this result.

Of course, the assumed data are too hypothetical for any dependence to be paid to these figures as exact results, but I think they suffice to show that the observations of "H. D. G." may thus be fairly accounted for.

His description of the sound heard as "er-er-pup-pup" would correspond with the general roll and the explosion from a pair of guns in the double line not fired exactly simultaneously, while the duration which he notes of about eleven seconds for the whole sound would correspond fairly well with the interval, some eighteen seconds, by which the sound from the last ships of the double line would be behind that from the first, and would seem to prove that the sounds from the single line farther westward were inaudible.

It is well known that the speed of sound in air does not depend directly on the density, but is affected by temperature, so that in an atmosphere of varying temperature the course of a ray must be curved. In the normal condition it is stated that the fall of temperature is about 1° C. in 330 feet of vertical height, and the consequence is that every ray of sound must be deflected *upwards*, and so at a little distance from the source would pass to the upper regions of the atmosphere over the heads of observers on the same horizontal line. This effect is probably small compared with that due to the wind. It would add to the upward bending effect for rays proceeding against the wind (in our case

westward), and somewhat flatten the curved paths with the wind; but it would not probably affect materially the general explanation above.

"H. D. G." truly observes that, owing to the curvature of the earth, his station was nearly 2000 feet below the horizontal line of Spithead, but this also would not materially alter our explanation.

So far for the sound heard at distant stations not very far from the east-west line from Spithead. When, however, we come to consider the case of Oxford and other places nearly due north, where the sound was heard, and in particular the duration of continuous sound (20 seconds) and succession of sounds and silences noted by Sir W. J. Herschel, our explanation entirely fails. It is true that the differences of distance from Oxford to the different ships were so small that the impulses from all the forty-six ships must have arrived within the interval of about half a second, but they would have diminished in intensity (according to the law of the inverse square of the distance, which in the absence of wind in their direction must be assumed) so as to be less strong than the impulse from a single gun at the distance of ten miles, a distance at which, we have seen, it would have been inaudible.

Was there a southerly current in the upper atmosphere between the Solent and Oxford? Or was the state of the atmosphere abnormal as to temperature, so that the upper regions were warmer than the lower, as hardly seems probable? Or, lastly, were the sounds heard by Sir W. J. Herschel diffraction effects outside the upward curving sound rays, as the intervals of sound and silence seem to suggest? Or is any other explanation possible from known laws?

Possibly some light may be thrown on these questions by other correspondents, or such experts as Sir G. Stokes, Lord Rayleigh or Prof. Osborne Reynolds.

The Cherbourg Peninsula at its northern end is about the same distance to the south of Spithead as Oxford to the north. It would be interesting to know if the sounds were heard by ships in the channel between the Isle of Wight and Cherbourg.

Robt. B. Hayward.

Ashcombe, Shanklin, March 12.

The New Star in Perseus.

In sending you a provisional light-curve of Dr. Anderson's new star for publication in Nature, my principal purpose has been to ascertain the nature of the curious fluctuations in the latter part of its course. I have no doubt that they are real, as even the slight irregularity in the descending curve, about March 5, has been independently detected in Leyden, and probably elsewhere also; but the periodicity that seems to establish itself in the past six or seven days may be only apparent. In this country the weather has been generally unfavourable for some weeks, and it is possible that astronomers in other parts of the world will be able to fill the gaps between the observed parts of the descending curve (on February 25, March 1, 3, 5, 6, 13, 17, 20, 21, 22, 23, 25, 27).

This star is remarkable in still another respect. It is a well-known fact that new stars have almost exclusively made their appearance in the Milky Way; moreover, it has been pointed out recently by Sir Norman Lockyer in this journal that the Novæ are not equally distributed along the galactic zone; like the "Wolf-Rayet" stars, they seem to avoid the region comprised between Cassiopeia and Carina. Nova Persei 1901 is no exception to the general rule, it being situated on a feeble distance of the central plane of the Milky Way, but as in the case with the other new star discovered by Dr. Anderson, in Auriga, it lies in a relatively poor region of the galactic zone, in which phenomena of this kind have but rarely occurred. Notwithstanding this, I think that the tendency among the new stars to group themselves in the opposite region of the Milky Way holds good as a rule.

C. Easton.

Rotterdam, March 27.

NOVA PERSEI.

The observations of the new star in Perseus have not decreased in interest since they were last referred to in Nature. Strictly according to precedent a nebular spectrum, somewhat similar to that observed by Gothard in Nova Aurigæ, followed the disappearance of the dark lines in the spectrum; but about the same time a new phenomenon in relation to Nova was observed; the star behaved like a "collision-variable."

Sudden changes of magnitude have been one of the most interesting features of this new star. Since the time (February 23) that the Nova attained its greatest brilliancy, the star gradually diminished in brightness, decreasing rather rapidly till the 13th March, and somewhat more slowly up to the 17th. Since this date periodical variations have occurred, the star decreasing to a 5·5 magnitude star and rising to about 4·2 in a period of three days (about). Thus minima were observed on March 19, 22, 25 and 28. On the evenings of the 30th, 31st and April 1 the star was of mag. 4·2, 4·3, 4·4, so that either another minimum had occurred between the times at which these observations were made or the periodicity is undergoing a change. It is important, therefore, that the light of the Nova should be observed as often as possible, so that such changes may be accurately determined.

Whether this result is due to the complete capture of the denser swarm or to other changes brought about in the sparser one, it is as yet impossible to say.

We append some extracts from a paper communicated to the Royal Society by Sir Norman Lockyer last Thursday.

Colour.—The colour has undergone some distinct changes since the observation on March 5 last, when it was shining with a claret-red hue. On the 9th and 10th it was observed to be much redder, due probably to the great development of the red C line of hydrogen.

On the 23rd and 24th the star was noted as yellowish-red, while on the 25th (after the sudden drop in magnitude) it was very red with perhaps a yellow tinge.

Since that date the star has again become much less red than formerly, and on April 1 was distinctly yellow with a reddish tinge.

The Visual Spectrum.—Since March 5 the spectrum has become much fainter, the bright lines of hydrogen being relatively more prominent than they were before; indeed, C and F throughout this period have been the most conspicuous lines, especially the former, while the bright lines $\lambda\lambda$ 5169, 5018 and 4924, and the line in the yellow at or near D, were the most prominent of the others.

All these lines have been gradually becoming weaker, but there is an indication that λ 5018 has been brightening relatively to λ 5169.

Accompanying the great diminution in the light of the Nova observed on the evening of the 25th, the spectrum was found to have undergone a great change: the continuous spectrum had practically disappeared, and a line near D (probably helium D^3) became more distinct. The other lines were hardly visible.

The Photographic Spectrum.—The spectral changes recorded in the photograph in one part of the spectrum follow suit with those observed visually in the other.

On March 6 the photograph was very similar to those obtained in the earlier stages, the only apparent difference being in the relative intensity of the bright hydrogen lines as opposed to those having other origins, most of which have been shown to be probably due to iron and calcium. The hydrogen lines have sensibly brightened, while the others have become much feebler.

The photograph of March 10 shows a further dimming of the bright lines other than those of hydrogen.

On March 25, when the next good photograph was taken, the spectrum had undergone great modifications. The hydrogen lines are still very bright, though they do not show the structure which they did in the photographs taken between February 25 and March 10. The bright lines other than those of hydrogen which are seen in the earlier photographs have now disappeared and other lines become visible. The continuous spectrum has also greatly diminished.

Rough determinations of the wave-length of these new lines have been made by Mr. Baxandall by interpolation between the hydrogen lines. They are as follows:—

387. Broad and merging into Hζ (3889).
436. Faint.
447. Not very strong. Probably Helium (λ4471·6).

456. Faint.

464. Very strong broad line. Possibly the 465 line of the bright-line stars.

468. Moderately strong. Possibly new hydrogen (λ 4686) seen in bright line stars.

471. Weak. Probably helium (λ 4713).

The hydrogen lines in the spectra are $H\zeta$, $H\epsilon$, $H\delta$, $H\gamma$ and $H\beta$.

The lines at λ 370 and 464 are perhaps identical with those observed by von Gothard[1] in the spectrum of Nova Aurigæ, after it had become nebular, but associated with these lines in his record there is the chief nebular line at 5006, no trace of which is yet visible in the spectrum of Nova Persei. On the other hand, $H\beta$, which is the brightest line in the present spectrum of Nova Persei, does not appear at all in von Gothard's spectrum of Nova Aurigæ.

Characteristics of the Hydrogen Lines.—A detailed examination of the lines as photographed on several evenings shows that their structure has been undergoing changes. On February 25 there were three points of maximum luminosity on the F line, the two maxima on the blue side being of equal intensity and greater than the third on the red side. By March 1 the centre one had greatly been reduced in magnitude, and on the 3rd it had been broken up into two portions, thus making four distinct maxima.

Rough measures made on the relative positions of these points of maxima show that the difference of velocity indicated between the two external maxima is nearly 1000 miles per second, while that between the two inner maxima is 200 per second. We thus have indications of possible rotations or spiral movements of two distinct sets of particles travelling with velocities of 500 and 100 miles per second.

A similar examination of the F and G lines of hydrogen in the photographs obtained with the 30-inch reflector has also been made by Dr. Lockyer. In this longer series the most important fact comes out that the change of maximum intensity changes from the more to the less refrangible side of the bright hydrogen line,[2] and the narrowing of the bright maximum in the middle.

So far as the observations have gone they strongly support, in my opinion, the view I put forward in 1877, that new stars are produced by the clash of meteor swarms. I have suggested some further tests of its validity.

We may hope, since observations were made at Harvard and Potsdam very near the epoch of maximum brilliancy, that a subsequent complete discussion of the results obtained will very largely increase our knowledge. The interesting question arises whether we may not regard the changes in spectra as indicating that the very violent intrusion of the denser swarm has been followed by its dissipation, and that its passage has produced movements in the sparser swarm which may eventuate in a subsequent condensation.

THE BEER POISONING EPIDEMIC.

THERE is now a pause in the literature of the most interesting, but at the same time most disastrous, beer poisoning epidemic, and the present seems a fitting opportunity to summarise the chief facts ascertained with regard to it, the deductions to be drawn from them, and, last but not least, the lessons which they teach so far as concerns the prevention of a recurrence of the calamity.

The first fact of transcendental importance was ascertained by Dr. Reynolds, namely, that the beer consumed by these unhappy individuals contained arsenic in such an amount as undoubtedly in many cases to account for the symptoms from which they suffered. So far as subsequent workers are concerned, their results have amply confirmed this fact, and there can be no doubt that the majority of patients in Manchester suffered from what has always been called arsenical poisoning. The next step was directed to ascertain how the arsenic got into the beer. Of this, fortunately, there can be no doubt it came into the beer from the sugar, and it got into the sugar through the sulphuric acid used either directly or indirectly in the manufacture of the invert sugar or the glucose. It is beside our purpose here to discuss whether all the cases of poisoning were due to the use of sugar made from sulphuric acid supplied either by one firm or prepared from one variety of pyrites. This, although a matter of paramount importance, is not essentially a matter for the man of science to decide. A definite answer to this question can only be obtained by the careful sifting of evidence, the examination of the books of various firms, &c., and is, indeed, a matter for the lawyer rather than for the chemist or pharmacologist. There can be no doubt, however, that the majority of cases observed could be traced to the consumption of beer and stout in the preparation of which sulphuric acid, supplied since the spring by one firm, had been used.

The next actual fact with regard to the causation of the epidemic was, unfortunately, discovered too late to allow of its full significance being thoroughly worked out. Two full months after the consumption of arsenicated beer had ceased, Dr. Tunnicliffe and Dr. Rosenheim demonstrated the presence in relatively large quantities (0·3 per cent.) of selenious acid in the sulphuric acid which was used in the preparation of the invert sugar supplied by the firm implicated in the recent epidemic. These observers subsequently further demonstrated the presence of this substance, which was, indeed, from their earlier work *a priori* almost certain, in the invert sugar itself and also in two different samples of beer identical with that consumed by the poisoned patients in Salford. They also pointed out at the same time that this substance is highly poisonous, certainly as, if not more, poisonous than arsenic, giving rise to symptoms almost identical with this latter poison. Exact quantitative estimations of the amount of selenium in the beer are, so far as we are aware, not yet published, but reckoning from the acid and the sugar we may calculate that this substance was present to the extent of about one quarter the amount of the arsenic present. It follows, then, that the beer consumed in the recent epidemic contained at least two poisonous substances, viz., arsenic and selenium, both of which got into the beer from the sulphuric acid used in the preparation of the sugar.

So far as concerns the actual ætiology of the epidemic, the above are all the facts which we have at present in our possession. Incidentally, however, numerous other points of extreme interest to the physician, the pharmacologist and toxicologist have arisen in the course of the inquiry.

So far as the pharmacology of arsenic is concerned, it is greatly to be regretted that our information concerning the exact amount of arsenic consumed by the individual patients is so inaccurate. This inaccuracy arises from two conditions. Firstly, it has not been in all cases absolutely established that the beer quantitatively examined for arsenic, although coming from the same source as, was identical with that consumed by the respective patients; secondly, the actual amount of beer taken by each patient was in many cases an unknown quantity. The largest amount of arsenious acid found in beer during the epidemic was 1·4 grains per gallon. Some of the sufferers undoubtedly consumed more than a gallon of beer per diem; some, however, did not consume more than a pint. This would mean that, although the former received a highly poisonous dose of arsenic, the latter would do so only in the cases of the very highly arsenicated beers, which were relatively rare. If we assume that arsenic was the only poisonous agent at work, we must also admit that it caused grave poisoning in very minute doses; in some cases, from the published records, these must have been as small as 1/200th of a grain per diem.

[1] *Ast. Phys. Journ.* vol. xii. p. 51, 1891.

[2] The latest photograph, taken on April 1 shows this peculiarity in a far more pronounced manner, the intensity of the less refrangible component of the hydrogen lines being more than four times that of the more refrangible component.

These profound symptoms of poisoning from such minute doses have given rise to various explanations. The fact that the toxic power of arsenic varies largely according to the chemical form in which it is present, the arseniates, for instance, being barely half as poisonous as the arsenites, has led many to assume that the arsenic was present in the beer either as an arsene, or even in some more subtle biological form. The work of Gossio and others upon the power of the penicillium brevicaule to form highly poisonous gaseous substances from minute traces of solid arsenic compounds has been adduced by many in support of this hypothesis.

A further consideration of interest in this connection is the fact that arsenic must be considered, at any rate to some extent, a cumulative poison. The interesting and minute work of Gautier upon the excretion of arsenic under normal conditions by the skin, the hair and the menstrual fluid, and the storing of it in the thyroid gland, the thymus gland and the brain, are of especial interest. The recent researches of Sslowzow should also find mention here. This observer found that in animals poisoned with arsenic the arsenic was stored in the liver, and further, that it formed a compound with the nucleins, which showed itself to be resistant to the action of hydrochloric acid and pepsin, and that it was, in all probability, stored in this form in the cell nuclei. This work, so far as concerns the storing of arsenic in the liver and its excretion by the epidermal appendages, has been recently confirmed by Dixon Mann.

That arsenic is slowly excreted has been known for some time. E. Ludwig found arsenic in the urine of a dog forty days after the last dose had been ingested, Wood found it in the urine of patients eighty and ninety days after intoxication with arsenic.

Although arsenic may be in this sense cumulative, it does not follow that its poisonous action is cumulative. In fact, its forming an indigestible nuclein compound speaks against this. Further, we know from clinical experience, from the Styrian arsenic eaters, and from numerous pharmacological experiments on animals, that tolerance to arsenic is easily produced. Indeed, continued small doses of arsenic, so far from causing symptoms allied to those which occurred in the beer poisoning epidemic, as a rule improve nutrition and have a general tonic action.

If we pass from the consideration of the nature of the poison to the symptoms which occurred in the Manchester patients, we find many points of extreme interest. Speaking generally, the phenomena present corresponded more or less closely with the classical symptoms of arsenical poisoning. It must be remembered, however, that the discovery of selenium opens the whole question of arsenical poisoning afresh. So far as pharmacological experiments upon animals go, the only difference between the chronic poisonous action of these two substances is that tolerance to selenium is apparently never produced, and that this substance, in continued small doses, produces wasting by virtue of a specific stimulating action which it exerts upon the breaking down of the nitrogenous constituents of the tissues. Thus we must confess that the presence of selenium along with arsenic in the Manchester beer explains many otherwise anomalous symptoms.

It has long been known that excess of alcoholic beverages causes in the drinkers a disease known as peripheral neuritis. The *rôle* played by alcohol in this disease has heretofore been regarded as sufficiently important to justify the designation of alcoholic neuritis for this condition. It has, however, been observed that the drinkers of certain kinds of alcoholic beverages are much more prone to this affection than the drinkers of others, and further, that the strength of the beverage in alcohol seems to bear no proportion to its proneness to cause so-called alcoholic neuritis. Drinkers of distilled spirits and wines are much less liable to suffer from peripheral neuritis than beer and stout drinkers. These considerations have led many physicians to look upon this disease as caused by the beverage rather than by the alcohol (C_2H_5OH). Peripheral neuritis was a prominent symptom in the Manchester epidemic, and there can be little doubt it was caused by the arsenic and selenium compounds in the beer. Other metallic and organic poisons, such, for instance, as beri-beri, give rise to a similar condition. This epidemic has, therefore, very much increased the previous doubt concerning the part played by alcohol itself in the so-called alcoholic neuritis.

With regard to the lessons to be learnt from the recent beer-poisoning epidemic, the chief one certainly is to beware of mineral acids in the preparation of all foodstuffs. It is difficult to see how mineral acids, or at any rate acids (in this connection must be observed the difficulty of freeing an acid like tartaric acid from lead) can be dispensed with. They can, however, certainly be put on the market, from whatever source they may be obtained, pure. Although absolute chemical purity must be regarded as a dream of the fatuous ignoramus, there should be no difficulty in the sulphuric acid manufacturers providing an acid which one can term at least harmlessly impure. A further important result of the investigations attending this epidemic is the discovery of selenium in poisonous doses in a beverage actually consumed. This substance has no doubt slipped in and out of many previous arsenic epidemics, escaping observation, as it were, between the stools of chemistry and pharmacology. Now that we are awake to its poisonous existence, in the next arsenic epidemic, which we hope may be long deferred, we shall be able, no doubt, to work out the exact part it plays. It is interesting to note in this connection that it is an impurity of both brimstone and pyrites acid, and that it occurs along with tellurium in certain Japanese sulphurs which are free from arsenic.

MUSICAL ARCS.

WE have already described in a previous issue (NATURE, December 20, 1900, p. 182) the discovery of a new musical instrument in the electric arc made by Mr. Duddell and communicated by him to the Institution of Electrical Engineers last December. The fame, if not the music, of Mr. Duddell's arc penetrated, it appears, to Vienna, where the experiments were repeated at the Technological Institute, and thence returned to the English lay Press. The *Daily Mail* of January 12 last contained an article on "Music in Flame," the result of an interview with Prof. Ayrton on the subject of Mr. Duddell's experiments, in the course of which he suggested that it might be possible to utilise the discovery for the purpose of public entertainment. Would it not be possible, for example, to play a tune upon the arc lamps used in lighting a hall, the musician being at a distance—even outside the building—and playing on the ingenious key-board devised by Mr. Duddell? At the time this article appeared the prophecy may have seemed somewhat extravagant. Mr. Duddell's experiments were conducted, it will be remembered, by shunting an arc burning between solid carbons—the cored carbon arc has no music in its soul—by a circuit containing capacity and self-induction, and the note emitted by the arc was varied by altering the capacity or self-induction in the shunt circuit. The shunt circuit was, however, placed directly across the terminals of the arc, and there was no evidence of any possibility of playing tunes on the arc from any distance; and, further, the arc lamps used in the experiment were hand-fed and it was not unreasonable to suppose that the mechanism and magnet coils of an automatic arc lamp would effectually interfere with the music.

Extravagant, however, as Prof. Ayrton's suggestion may have seemed, it appears from Mr. Duddell's reply to the discussion on his paper (just published in the *Journal* of the Institution of Electrical Engineers) that it is more than justified by the truth. During the time that Mr. Duddell was experimenting on the musical arc at the Central Technical College, Mr. Bradfield noticed that an arc with which he was experimenting in Sir W. de W. Abney's laboratory started playing tunes. About the same time also Sir Norman Lockyer noticed that the arc in his laboratory was behaving in an erratic manner, though he did not detect any definite tune. At the time neither Mr. Bradfield nor Sir Norman Lockyer were able to account for this strange behaviour, but on the publication of Mr. Duddell's paper the explanation became evident. All the arcs were being supplied from the street mains and the disturbances were due to the shunt circuit with which Mr. Duddell was working at the Central Technical College. The arcs at Sir W. Abney's and Sir Norman Lockyer's laboratories were thus able to detect and repeat the tunes Mr. Duddell was playing on his arc, although they were in no way adjusted to make them specially sensitive, and were only connected to Mr. Duddell's arc by virtue of being on the same distributing network of supply mains. Sir. W. Abney's laboratory is on the opposite side of the road to the Central Technical College and at a distance of about 400 yards in a straight line, and at a much greater distance if measured along the street mains. Sir Norman Lockyer's laboratory is at about the same distance, on the same side of the road as the College.

If such remarkable results as these can be obtained without any design or arrangements of the circuit, who shall say what cannot be effected by a proper study of the best conditions and attention to the necessary details? Those who heard the music discoursed by the arcs at the Institution of Electrical Engineers will agree that some improvement is necessary before the arc can compete as a musical instrument with the violin or grand organ. But it is sufficiently demonstrated, we think, that Prof. Ayrton's prophecy is by no means excessive, and the time is perhaps not far distant when every central station will have its resident musician to play patriotic airs on the street arcs at the Coronation of the King and like occasions, and we shall be able to realise something of the grandeur of "the morning stars singing together."

LITTLE'S EXPEDITION TO OMI AND THE TIBETAN BORDER.[1]

A HOLIDAY trip from Central China (Chung-King), through the red sandstone basin of western Sze Chuan to the granite frontiers of Tibet, and back again by the traditional water-highway of the Yangtse, is not an experience which falls within the reach of every mercantile explorer in the East; and it derives additional interest in Mr. Little's case from the fact that he was accompanied by his wife. The story of the expedition is told in the form of a diary, a form in which it is almost impossible to avoid a certain amount of monotonous reiteration of incident in the daily record of progress, and which is, perhaps, a little too official in its method for an ordinary traveller's tale; but it is interesting all through, and the deductions which Mr. Little draws from his observations afford valuable food for reflection to those who look to the opening up of China to western methods of economic development. From Chung King to Kia ting, the town which lies at the foot of the classical Omi (the Fusilama of western China), Mr. Little and his wife adopted the Chinese traditional mode of transport, which consists of a sedan chair carried on the shoulders of coolies; and it is a method which, in the present stage of Chinese social advancement, secures for a traveller as much respect and attention as a coach-and-four would in England. It at once lifts him morally and physically above the steaming crowds of humanity which, in a region which is free from the depleting processes of famine, swarm together in one great pitiless struggle for existence. The whole basin of the Yangtse to the foot of the western mountains presents the same aspect of overcrowded population. Every acre of available soil is cultivated, every yard of productive land is occupied. There is no room to pitch even the smallest of tents, and travellers have perforce to put up with the accommodation afforded by the indigenous hotel. It is the varied nature of the sort of entertainment which is found at these Chinese inns, with the everlasting accompaniment of personal unrestrained curiosity on the part of a people who look on all foreign devils (especially a feminine devil) as fair game for their inquisitiveness, which forms the leading feature in Mr. Little's account of his outward journey. The trip was made in 1897, and it is worthy of remark (*àpropos* of more recent events in China) that even then Mr. Little was able to discern a very considerable change for the worse in the attitude of the people towards strangers; and this change had taken place during the previous ten years. Fifteen years before Mr. Little's journey that delightful writer and traveller, Baber, had visited western Sze Chuan and Mount Omi, and his account of his travels certainly tends to confirm Mr. Little's view that a growing antipathy to foreign incursions was gradually accumulating which would eventually tend to mischievous results. Our travellers were occasionally treated to something worse than the derisive jeers of the townspeople. "Clods of earth and cabbage-stalks" now and then followed the maledictions of the crowd. And yet there was much good-natured hospitality and courtesy frequently shown both by priests and people. How far the interference of missionaries with the old traditions of a form of Buddhism which seems to be of a far higher and purer type in western China than anything in Tibet, may have influenced the minds of the people is open to question. Mr. Little is evidently doubtful on the point. With every desire to give missionaries credit for their devoted spirit of enterprise, he seems to think that their efforts in the work of regeneration have not always been wisely directed.

Of the wonderful beauty of Mount Omi scenery, its temples and groves, its priests, its pilgrims and its precipices (from the summit of one of which the crowning "glory of Buddha" is to be seen), Mr. Little has much to say, and he says it well. When the Chinese introduce railways more freely into their country, along with that "western knowledge and machinery" which is to give to them the "command of the industrial world," Omi (beloved of Baber and photographed by Mrs. Little) will be as much an object of western pilgrimage as of eastern.

Mr. Little makes the height of Omi to be 10,500 feet above sea, and Sai King Shan (a mountain which he subsequently visited), 11,100. This exactly reverses the altitudes given by Baber, who makes Omi 11,100 feet—the height which is preserved in Mr. Little's map. Hypsometrical determinations are proverbially unsatisfactory, especially when the observations are made under the influence of very varied "weather" conditions. Possibly, also, Mr. Little's results may be affected by the fact that he "boiled his thermometer" (he says he did so, repeatedly) instead of registering the temperature of the steam.

The Littles did not penetrate far into Tibet. Indeed, it depends on whether Ta chien lu (Dar chen do; both names seem to be correct) is to be regarded as the frontier of Tibet, or whether the boundary is politically (as it is geographically) to be found in the Tung river.

[1] "Mount Omi and Beyond." By A. J. Little. Pp. xiv + 272. (London: W. Heinemann, 1901.)

Ta chien lu is a typical Tibetan town, with its "curved roofs, gilded pinnacles surrounded by a mediæval wall," and its extensive and gaudy "lamasarai" Walled in by gigantic mountains as it is, Ta chien lu has become a most important economic and strategical centre. Since the Koko Nor trade route has been abandoned, all the trade of Tibet (skins, wool, gold and musk) passes into China this way; and it is by this route that the soft, irruptive Chinese tide made its way, by sheer force of patient persistence, into the strongholds of the hardy Tibetan and reduced Tibet to a dependency. Mr. Little hardly appreciates the chicken-hearted nature of Tibetan morale, so much is it disguised by the stalwart, muscular personality of the mountain-bred nomad. The Tibetan submits to slipshod Chinese domination without a murmur.

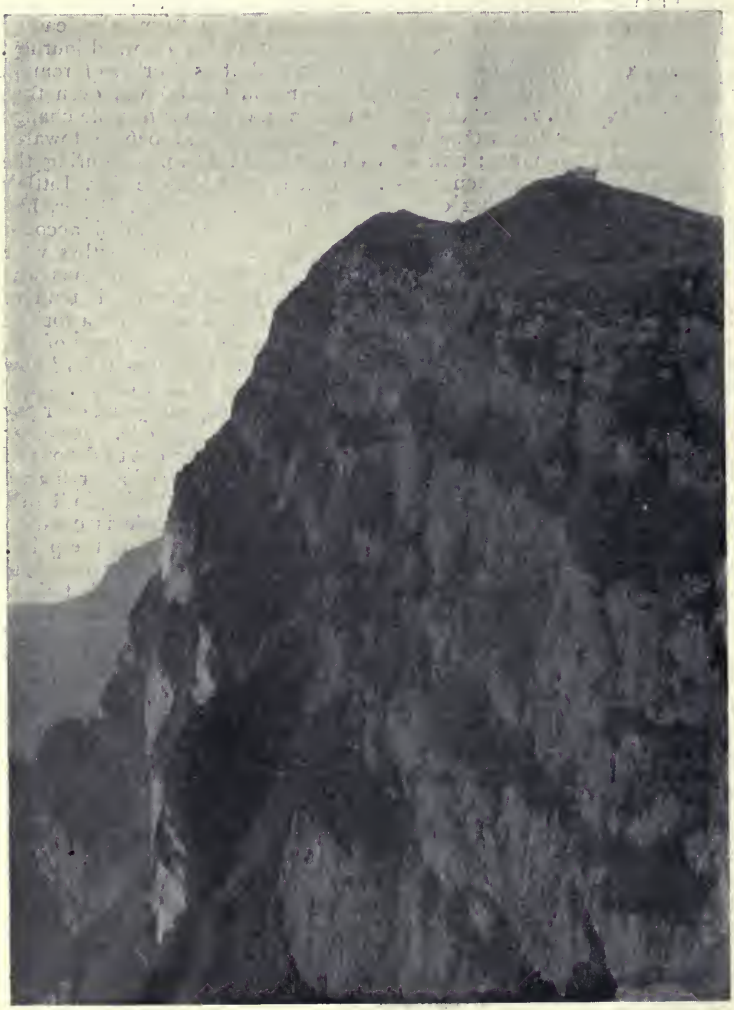

FIG. 1.—Summit of Mount Omi, with Temples.

Ta chien lu is the great western tea mart, and the trade (along with pawnbroking, according to other observers) is altogether in the hands of the Lamas. The manufacture of brick tea for the Tibetan market is faithfully described. It is enough to say that Tibetans like the tea so manufactured, and will "use no other." The bridge at Luting over the Tung, which alone makes the route practicable, is a work of Chinese enterprise which has now lasted for 200 years without repair. It is an iron suspension bridge, and for details of its construction (which are really worth attentive study) the reader cannot do better than refer to Mr. Little's book.

The return journey down the Yangtse, through the rapids and reaches of its upper course, is a feature in the story which will be more or less familiar to many recent travellers. The book is interesting throughout, and not the least value of it is the vista which it opens up of future economic possibilities in that teeming eastern region, the Yangtse basin.

PROF. JOSEF VON FODOR.

BY the death of Prof. von Fodor, of Budapest, the eastern part of Europe has lost its great teacher of hygiene, and the world one of its most diligent investigators in the domain of public health. His investigations had chiefly to do with the soil, subsoil water and ground air, and his authority on these matters is universally recognised. His chief treatises were on air, water and soil in connection with diseases, to which a happy reference was made by the public orator at Cambridge when von Fodor was awarded the hon. LL.D. degree on the occasion of the London meeting of the International Congress of Hygiene and Demography in 1891, as follows:—

"Quis nescit urbem florentissimam, quod Hungariæ caput est, nomine bilingui nuncupatam, fluminis Danubii in utraque ripa esse positam. Quis non inde nobis feliciter advectum esse gaudet salutis publicæ professorem insignem, virum titulis plurimis cumulatum, qui etiam de Angliæ salubritate opus egregium conscripsit? Idem, velut alter Hippocrates, de aëre, aquis et locis præclare disseruit. Olim Hippocrates ipse corona aurea Atheniensium in theatro donatus est; nos Hippocratis æmulum illustrem laurea nostra qualicunque in hoc templo honoris libenter ornamus.

Duco ad vos bacteriologiæ cultorem accerrimum, Iosephum de Fodor"

Of this degree von Fodor was justly proud, as he showed by wearing the scarlet gown to which it entitled him on important occasions.

He was a sincere, unaffected and amiable man, whose premature death has been a very severe shock to his many friends and admirers.

W. H. C.

NOTES.

A MEETING of the local branch of the general committee for the purpose of founding a memorial to the late Prof. Fitzgerald was held on March 28 in Trinity College, Dublin. Dr. Tarleton presided. The meeting was attended by representatives of the leading societies and clubs of the University. It was resolved that the proposed memorial would most appropriately take the form of an endowment of research in physical science by advanced students. In this manner the work of the late professor would best be carried forward. Letters were read from many distinguished scientific men expressing sympathy with the movement. An executive committee was elected and

empowered to take the requisite steps to afford the many friends and admirers of the late Prof. Fitzgerald an opportunity of forwarding the object in view.

M. SABATIER, professor of chemistry in the University of Toulouse, has been elected a member of the section of chemistry of the Paris Academy of Sciences, in succession to M. Haller, who has been elected a member of the Academy. Prof. Davidson, of the University of California, has been elected a correspondant of the section of geography and navigation.

THE American Academy of Arts and Sciences elected the following foreign honorary members at the last meeting:—Prof. J. H. Poincaré, Paris (Mathematics and Astronomy); Prof. Henrich Müller-Breslau, Berlin (Technology and Engineering); Prof. H. Kronecker, Bern (Zoology and Physiology); Prof. R. Koch, Berlin (Medicine and Surgery); Sir T. Lauder Brunton, London (Medicine and Surgery); Prof. A. V. Dicey, Oxford (Philosophy and Jurisprudence); Mr. W. E. Hearn, Melbourne (Philosophy and Jurisprudence); and Dr. Henry Jackson, Cambridge (Philosophy and Archæology).

THE ninth James Forrest lecture of the Institution of Civil Engineers will be delivered by Dr. Frank Clowes on April 25. The subject will be "Chemistry in its Relations to Engineering."

THE *Frankfurter Zeitung* announces the death, at Waiblingen, Wurtemberg, from malaria, of Dr. Schlichter, the well-known African traveller and geographer.

THE death is announced of Mr. W. Hodgson, who for more than half a century devoted his leisure to the collection of facts relating to the flora of his native county, Cumberland. He was the author of a "Flora of Cumberland," which was published about two years ago.

THE *Athenaeum* announces the death of Dr. Franz Melde, professor of astronomy and physics and director of the mathematical and physical institute of the University of Marburg, on March 17, at the age of sixty-nine. Dr. Melde distinguished himself in every branch of experimental physics, notably in his special subject acoustics, and his book on "Zeitbestimmungen" proved a valuable contribution to astronomy.

REUTER'S Agency is informed that the whaler *America*, which has been bought by Mr. Evelyn B. Baldwin, the American explorer, for his forthcoming journey to the North Pole, will sail from Dundee on June 18, by which date Mr. Baldwin expects to arrive from the United States. The *America* will proceed direct to Norway, where she will join the two other ships which are to form part of the expedition, and, after taking on board stores and equipment, will procee for the North.

THE ship which has been built for the German Antarctic Expedition was launched at Kiel on Tuesday. The Berlin correspondent of the *Times* states that among those who were present at the ceremony were Count Posadowsky, the Secretary of State for Home Affairs, Prof. von Drygalski, who will have charge of the expedition, and representatives of the Foreign Office, the Admiralty, and the local authorities. The vessel was christened the *Gauss* by Prof. Baron von Richthofen, who the course of a short speech said that the German nation would follow the fortunes of the expedition with hope and with anxiety. The name *Gauss* was selected by order of the Emperor in honour of the Göttingen professor, the late Karl Friedrich Gauss, who did much to stimulate Antarctic research. A telegram was received from Count von Bülow cordially wishing the expedition every success.

THE following are among the lecture arrangements at the Royal Institution, after Easter:—Dr. Allan Macfadyen, six lectures on cellular physiology, with special reference to the enzymes and ferments; Mr. Roger Fry, two lectures on naturalism in Italian painting; Prof. Dewar, three lectures on the chemistry of carbon; Prof. W. M. Flinders Petrie, three lectures on the rise of civilisation in Egypt; Prof. J. B. Farmer, two lectures on the biological characters of epiphytic plants; Mr. J. Y. Buchanan, three lectures on climate: its causes and effects. The Friday evening meetings will be resumed on April 19, when a discourse will be delivered by Prof. J. J. Thomson on the existence of bodies smaller than atoms. Succeeding discourses will probably be given by Dr. Hans Gadow, Mr. Charles Mercier, Prof. J. Chunder Bose, Mr. R. T. Glazebrook, Mr. A. Henry Savage Landor, and other gentlemen.

THE annual meeting of the Iron and Steel Institute will be held in London on May 8 and 9. As a tribute of respect to the memory of her late Majesty the Queen, it has been decided that the usual annual dinner shall not be held this year. At the opening meeting on May 8 the retiring president, Sir William Roberts-Austen, K.C.B., will induct into the chair the president-elect, Mr. William Whitwell. The Bessemer Gold Medal for 1901 will be presented to Mr. J. E. Stead. Among the papers that are expected to be submitted to the meeting are the following:—On the properties of steel castings, by Prof. J. O. Arnold; on the physical properties of steel, by Mr. J. A. Brinell; on the heat of formation of carbides and silicides of iron, by Mr. E. D. Campbell; on the use of hydraulic power in the manufacture of iron and steel, by Mr. R. M. Daelen (Düsseldorf); on dust in blast-furnace gas, by Mr. A. Greiner; on the economical significance of high silicon in pig iron for the acid steel processes, by Mr. Axel Sahlin; on crystals of carbo-silicide of manganese and iron from a blast-furnace burden, by Mr. J. E. Stead; on the effect of copper in steel rails and plates, by Messrs. J. E. Stead and John Evans (Middlesbrough); on the measurement of Young's modulus for iron rods by tension and by bending, by Mr. H. E. Wimperis. The autumn meeting of the Institute will be held in Glasgow on September 3 and following days, simultaneously with the holding of the International Engineering Congress, of section V. (Iron and Steel), of which the Iron and Steel Institute has undertaken to take charge.

THE annual general meeting of the Chemical Society was held on Thursday, March 28. Dr. T. E. Thorpe, who occupied the chair, referred to the death of her late Majesty Queen Victoria, and said he was proud to think that the Chemical Society, in so far as it had ministered to the progress of chemistry, contributed in some measure to the lustre of a reign so pre-eminently associated with the development and spread of science in this country, and with the extension of those arts which rest upon chemistry. During the past year the publications of the Society were exceptionally full and valuable. The volume of *Transactions* for 1900 contained no less than four memorial lectures, giving an account of the life-work of Victor Meyer, Bunsen, Friedel and Nilson. The council had determined to issue those memorial lectures which had appeared up to the end of 1900 in a separate form. Acting upon the result of the voting of the Fellows on the question of the day and hour of meeting, the council had decided that the suggested change should be provisionally tried during the coming session. The ordinary meetings of next session would therefore be held on the first and third Wednesdays of the month, at 5.30 p.m. A reference was made to the movement for a uniform system of atomic weights, and it was announced that a committee of the Society had decided to recommend (1) that $O=16$ be taken as the basis of calculation of atomic weights; (2) that in assigning a number as the atomic weight of any element only so many figures should be employed that the last may be regarded as

accurately known to one unit in that figure. Prof. J. Emerson Reynolds was elected president of the Society, in succession to Dr. Thorpe. At the annual dinner of the Society, held on Wednesday, March 27, toasts were proposed and acknowledged by Dr. Thorpe (who presided), Prof. Tilden, the Lord Chancellor, Sir Herbert Maxwell, Lord Kelvin, Prof. Dewar, Mr. A. B. Kempe, Prof. S. P. Thompson, Prof. Emerson Reynolds, Sir W. S. Church, Sir Francis Mowatt and Sir Henry Roscoe.

AT the annual meeting of the Institution of Naval Architects, on March 27–29, the Earl of Glasgow was elected president. The next meeting of the Institution will be held at Glasgow, on June 25–28. An international engineering congress will be held in Glasgow early in September, and the Institution has undertaken the management of the section relating to naval architecture and marine engineering. The Earl of Glasgow delivered an address, in which he reviewed the progress of shipping during the past year, commenting upon the announcement recently made by the First Lord of the Admiralty, that, for the first time in our history, submarine boats have been ordered for experimental purposes. At the close of the president's address, Prof. G. H. Bryan, F.R.S., was presented with the gold medal of the Institution for his paper on the action of bilge keels. Prof. J. H. Biles then read a paper on naval construction in the United States. Among other matters he noted some rather important details common to the larger classes of American ships. Cofferdams filled with obturating material, which is expected to expand when in contact with the water, are fitted very generally at the sides of the ship. This material is the pith of the corn stock, and has been experimented upon very fully by the navy department, with the result that designs have been prepared with the intention of adopting it generally. It is evident that if the corn stock material swells when in contact with water sufficiently to fill up holes made by shot, it will have an important effect upon the margin of stability and probably of buoyancy of a ship in action. Another paper read before the Institution was on an instrument for measuring the rolling of ships, by Mr. A. Mallock, who, after pointing out the difficulty of accurately measuring the angle of roll of a ship, described an indicator which would give a very accurate measure of the rolls in all circumstances.

IMPORTANT papers were read at the meeting referred to in the foregoing note. Herr Otto Schlick described experiments to determine the cause of small vibrations in the *Deutschland* during her trial trip in June last. The conclusion arrived at from his experiments is that one blade of the propeller has a greater resistance in turning than the other blades, or that the opposite blade has a correspondingly less resistance. Such greater resistance of the one blade is in most cases probably to be attributed to its greater pitch. The least deviation in the pitch, which cannot be proved by ordinary instruments, appears to cause perceptible vertical vibrations, and therefore the greatest care should be taken in the manufacture of propellers, not only for the sake of doing away with vibration, but also to save power and prevent breakage of the blades. Mr. C. H. Wingfield discussed the view that the thrust of a submerged propeller is greatest on those parts of the blade which are most deeply immersed, and gave reasons for an opposite conclusion. Papers on the mathematics of engine-balancing were read by Mr. J. Macfarlane Gray and Prof. W. E. Dalby. Captain W. Hovgaard, of the Danish Navy, dealt with the motion of submarine boats in a vertical plane. He pointed out that for such submarine boats as are now generally constructed, of from 100 to 200 tons displacement, and with our present means of underwater propulsion, a speed above twelve knots must be considered high. Mathematical considerations show that such boats should be long, deep, and comparatively narrow, with great metacentric height. Moreover, the necessity for drawing the centre of gravity forward and the centre of lateral resistance aft leads to a deep, narrow forebody and a flat and broad aftbody, with large horizontal fins aft. The French submarine boats *Gustave Zédé*, *Morse* and others approximate to this type. Boats of less than six knots may be regarded as of low speed. In such boats great length is not necessary, and, on the whole, is objectionable as regards internal arrangements and weight of hull. In them it is not requisite to draw the centre of lateral resistance so far aft of the centre of gravity as in the high-speed boat, and they should, therefore, be of short length, small depth and great breadth. The metacentric height should be made as great as possible by a low centre of gravity, and large horizontal fins should be fitted aft. The Holland Torpedo Boat Company's first boat, the *Holland*, approaches this type, but differs in having greater depth and stability. For submarine boats to be able to travel below the surface for a distance of two, or perhaps three, miles is sufficient for most purposes.

MR. H. G. WELLS commences, in the current number of the *Fortnightly Review*, a series of speculative papers upon some changes of civilised life and conditions of living likely to occur in the new century. To construct a prehistoric animal from one or two fossil bones is a much easier task than the prediction of future developments from the point of view of the present; but Mr. Wells attempts to do this, and even if his prophetic visions do not materialise they will convince the conservative mind that there is some virtue in dissatisfaction at many of the methods of to-day. The subject of the first article is land locomotion in the twentieth century, and it scarcely requires a prophetic afflatus to know that the present systems will be largely superseded or modified. Horse traffic, with its cruelty and filth, while the animals exhaust and pollute the air, must give place to motor carriages in a few years. The railways will then develop in order to save themselves. There will be continuous trains, working perhaps upon a plan like that of the moving platform of the Paris Exhibition, or utilising the principle of the rotating platform outlined by Prof. Perry in these columns (vol. lxii. p. 412, 1900). Nothing is said about the possibilities of aëronautics, not because of any doubt as to its final practicability, but because "I do not think it at all probable that aëronautics will ever come into play as a serious modification of transport and communication." It is, of course, impossible to project ourselves into the future so as to say exactly what will or will not come to pass; for an estimate of future performances can only be made with the material now available, and it leaves out of account the completely novel discoveries which often revolutionise the whole conditions. Nevertheless, it is not unprofitable to meditate upon the promise of progress.

AN address on weather knowledge and agriculture, delivered by Dr. Richard Börnstein at the Royal College of Agriculture of Berlin, in celebration of the Kaiser's birthday and of the two hundredth anniversary of the foundation of the kingdom of Prussia, has recently been issued in pamphlet form ("Wetterkunde und Landwirtschaft." Berlin: Paul Parey). Its concluding pages refer in most complimentary terms to the Kaiser's generous share in the promotion of scientific ballooning in Berlin, but the bulk of the address deals with the development of the German service of weather forecasts, and with suggestions for improving their accuracy and utility. Dr. Börnstein would have forecasts issued by local meteorological authorities, based on information supplied by telegraph from a central department and supplemented by knowledge of local climatology; he would also secure a more intelligent use of the information conveyed in the forecasts by the extension of instruction in the laws

of atmospheric changes. It is not in Germany alone that such knowledge would be of advantage. There are occasions in which the weather in any one or more of the districts of the British Isles could be easily characterised by a single word of one or more syllables, but to go a little further into detail and make a forecast describing the weather of the ensuing twenty-four hours in ten words, and no more, requires, on the part of the recipient, some intelligent acquaintance at least with weather telegraphese. It appears that in Germany the local authorities have taken the matter up with the prospect, according to Dr. Börnstein, of securing a more effective weather service than any other country in Europe.

THE paper on combined trolley and conduit tramway systems, read by Mr. A. N. Connett at the last meeting of the Institution of Mechanical Engineers, is one of considerable interest and importance. Of the four systems of electric tramways only the conduit and the trolley can be considered to be commercially practicable, since the surface contact system, though not wanting many and distinguished advocates, can hardly be said to be properly out of the experimental stage, and the accumulator system is still waiting for a thoroughly satisfactory traction cell. The trolley and the conduit are both in wide use, especially in America and on the Continent, and there are many lines at work combining the two systems. The trolley is objected to in large towns on the ground of its ugliness, its potential danger and the disadvantage involved in using the track rails as a return conductor. The conduit, on the other hand, is too expensive for country or suburban lines where the cheaper trolley is admissible. We have, therefore, in the case of tramways running into crowded towns from the outlying districts, a need for a combined system; this involves a special construction of the car to enable a quick change to be made from the one system to the other at the point of junction, and it is the problem thus raised that Mr. Connett discusses. The paper also deals at some length with the relative merits of side and centre slots for the conduit system, and gives a comparative estimate of the costs of installing conduit and trolley systems respectively; it is to be noted that the conduit is about twice as expensive as the trolley.

ACCORDING to a recent report the expectations of the constructors of the great Chicago Drainage Canal, which was made for carrying away the sewage of the city, containing over a million inhabitants, have been realised. The idea of pouring the sewage of a large city, amounting to 50,000 cubic feet a minute, into an open channel and allowing it to flow away without any attempt at purification was both novel and startling. Now it appears, after eight months' working, none of the actions threatened by the towns bordering on the river below Chicago have been commenced, and it is reported by competent authorities that the water in the canal is free from objectionable features. In fact, the water-way is used largely by pleasure boats and the water taken by the manufactories situated on the banks. It has also been found, on investigation by the Government Commission, that so far no appreciable effect has been made in lowering the water in Lake Michigan, a consequence that excited at one time great fears on the part of the harbour authorities round the coast. The immunity from the objectionable conditions which prevail in the Manchester Ship Canal owing to sewage being discharged into it is due to the large volume of clean water that is always passing down the water-way from Lake Michigan, a stream 22 feet deep and running at the rate of a mile an hour being sufficient to neutralise the foul condition of the 50,000 cubic feet of sewage sent into it every minute.

THE embryos of the New Zealand tuatera lizard recently received in this country have afforded to Mr. H. S. Harrison opportunities for studying the early dental developments of that remarkable reptile, the results of which are published in the *Quarterly Journal of Microscopical Science* for March. The outcome of these studies is to show that Sphenodon (or, as it is often incorrectly called, Hatteria) in its early stages possesses numerous sharp-pointed teeth very similar to those of many ordinary lizards; and as these are of irregular size at a certain period, it is inferred that they represent several coalesced dental series. On the completion of this alternating series a period of repose occurs, after which a development of uniform teeth takes place. By a secondary formation of bone round their bases, these teeth acquire what may be called false sockets. Subsequently the sides of the jaws are invested with a highly calcified layer of bone, which, when the teeth become worn down and the sides of the jaws exposed, assists the edges of the latter in the assumption of dental functions in the adult.

TO those interested in domesticated animals, whether from the point of view of the breeder or of the study of variation under human influence, the spring number of *Bibby's Quarterly* should prove very welcome, as it contains an unusually large number of reproductions of photographs of prize and other cattle, sheep, horses, &c. As marking the changes introduced by breeders, such photographs are of very considerable importance, and their reproduction in a journal of this description renders them accessible to all. A feature of the present number is an article by Prof. J. C. Ewart on "Prepotency and Exclusive Inheritance." The numerous photogravures in this article illustrate the predominating influence of one or other parents on their offspring in many breeds of domesticated animals. In an article on Boer farm life, attention cannot fail to be arrested by the photogravures of an arum-field and of flocks of domesticated ostriches. Arums, it appears, are grown as food both for pigs and ostriches.

OPPORTUNITY to study the geology and physical geography of the basin of the Thames is afforded by the Saturday afternoon excursions of the London Geological Field Class, which commence on April 27. Visits have been arranged to places of geological interest both north and south of London, and the excursions provide exceptional facilities for examining some of the greater movements which the south-east of England has experienced. Particulars can be obtained from the honorary general secretary, Mr. R. H. Bentley, 43, Gloucester Road, Brownswood Park, N.

REFERRING to the periodic variations of glaciers, the remark was made in our issue of March 7 (p. 444) that, in the Swiss Alps "of fifty-seven glaciers observed in 1897, fifty were still decreasing, five were stationary and twelve were increasing." A correspondent points out that this would make sixty-seven glaciers observed, and the author informs us that the difference arose from a clerical error in copying the numbers from the original memoir. The number thirty-nine should be substituted for fifty, making the total number of glaciers observed to be fifty-six instead of fifty-seven.

THE first place in the March number of *La Geographie* is given to a review of Colonel Yates' book on Khurasan and Sistan, by Prof. Vambéry. M. Bonin continues his account of a journey from Pekin to Russian Turkestan by Mongolia, Koko-Nor, Lob-Nor and Dzoungaria. Papers on three expeditions in the French Congo region are contributed by MM. Jobit, Lœfler and Huot, and Mr. J. W. Hodge reviews recent ethnographic and archæological explorations in the United States.

WE have received a copy of the "Report of Progress of the Survey of Tides and Currents in Canadian Waters" for the year ending June 30, 1900, by Mr. W. Bell Dawson, engineer in charge. Considerable advance has been made in the preparation of tide-tables, and a pamphlet issued during the year on the currents in the Gulf of St. Lawrence has already been

noticed in these columns. The observations secured during the year will, when worked up, afford an accurate knowledge of the times of the tides and of the turning of the tidal streams in the lower St. Lawrence. Many new observations of the tide-levels at different stations have also been obtained.

A METHOD for the preparation of amides from the corresponding aldehydes, which appears to be of general application, is described by Messrs. Pickard and Carter in the April number of the *Journal* of the Chemical Society. The aldehyde dissolved or suspended in water is shaken with a slight excess of ammonium persulphate and a certain quantity of lime, and after the reaction is over there is no difficulty in separating the amide in quantities amounting to 30 to 40 per cent. of the aldehyde taken. The method also lends itself to the preparation of alkyl-substituted amides, potassium persulphate being substituted for the ammonium salt and the alkylamine being present.

THE following species, among others, have been taken at Plymouth recently by the Marine Biological Association:—Mollusca: *Æolis aurantiaca*, *Gastrochaena modiolina*. Crustacea: *Achaeus Cranchii*. Polychæta: *Magelona papillicornis*, *Owenia fusiformis*, *Scalisetosus assimile*. Echinoderma: *Ophiocnida brachiata*. Hydrozoa: *Heterocordyle Conybeari*, *Syncoryne Loveni*. The pelagic fauna is increasing in richness and variety. The following have been taken:—Medusæ: *Amphicodon amphipleurus*, *Margelium octopunctatum*. Crustaceæ: *Podon intermedius*; large numbers of the nauplii and the *Cypris* stage of *Balanus*. Polychæta: post-larval stages of *Arenicola*, Trochospheres and later larvæ of Polynoids and Phyllodocids. Among the species breeding may be mentioned the following:—Crustacea: *Porcellana platycheles*, *Zantho rivulosus*; several species of *Portunus* and *Stenorhynchus phalangium*. Polychæta: *Myrianida pennigera*, *Polynoe scolopendrina*. Hydrozoa: *Hydrallmania falcata*, *Tubularia indivisa*, *Syncoryne Loveni*, *Garveia nutans*, *Diphasia rosacea*, *Sertularia argentea*, *Eudendrium ramosum*.

THE additions to the Zoological Society's Gardens during the past week include a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. R. Kirkwood; a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. H. E. Jung; a Common Coot (*Fulica atra*), European, presented by Mr. M. C. H. Hammond; two Picui Doves (*Columbula picui*) from South America, a Red-vented Bulbul (*Pycnonotus haemorrhous*) from India, presented by Mr. D. Seth-Smith; a Huanaco (*Lama huanacos*) from Bolivia, a Tawny Eagle (*Aquila naevioides*) from the Seychelles, a Nilotic Crocodile (*Crocodilus niloticus*) from Africa, four Menobranchs (*Necturus maculatus*) from North America, a West African Python (*Python sebae*) from West Africa, deposited; two Straw-necked Ibises (*Carphibis spinicollis*) from Australia, purchased; a Sykes Oriole (*Oriolus kundoo*), received in exchange.

OUR ASTRONOMICAL COLUMN.

RUTHERFURD MEASURES OF PLEIADES.—In the *Contributions from the Observatory of Columbia University*, No. 17, Mr. Harold Jacoby furnishes a revised discussion of the series of measures made by Rutherfurd of photographs of the Pleiades group dating from the years 1872 and 1874. The results of the first investigation were published in 1892, and are slightly modified in the present paper. Special reductions have been made to test the possibility of there being systematic errors arising from some form of optical distortion of the object-glass, and comparisons are given of heliometer and photographic measures. The final data are collected to form a catalogue of seventy-five stars in the cluster.

CATALOGUE OF SOUTHERN VARIABLE STARS.—Mr. Alexander W. Roberts has recently published in the *Astronomical Journal* (Nos. 491 492) a catalogue of the positions, magnitudes and elements of variable stars south of $-30°$ declination, reduced from observations made at the Lovedale Observatory with a $3\frac{1}{4}$-inch telescope during the years 1891–1899. In connection with the elements a new departure has been made by considering the epoch of a variable as the first maximum passage during 1900, all the stars being uniformly treated on this plan, except that Algol-variables are reckoned from the first *minimum* passage.

The author finds that the short-period variables have a mean variation of 1 magnitude, while the variation of the long-period class amounts to about 4·0 magnitudes. Reference is made to the possible connection of distinctive colours to the various types of variables.

The catalogue gives particulars of ninety-three variables, copious notes being included in explanation of individual stars.

ON A SOLAR CALORIMETER DEPENDING ON THE RATE OF GENERATION OF STEAM.

THIS instrument was shortly described in a note[1] which was communicated to the Royal Society of Edinburgh in July, 1882, and it has been fully described and figured in a paper[2] read before the Philosophical Society of Cambridge in December, 1900. In this paper the results obtained in Egypt in 1882 are detailed and discussed.

My object in designing the instrument and in taking it to Egypt was to find out for myself the amount of heat which can be actually collected from the sun's rays at or near the sea-level under favourable conditions. In such circumstances this amount must fall on land and sea alike, and it is the energy of this radiation which maintains the terrestrial economy.

The instrument measures the sun's heat in the same way as the calorific value of other fuels is commonly measured, namely, by the quantity of boiling water which a given quantity of it can transform into steam of the same temperature in a given time. The quantity of the sun's radiation used is measured by the capacity of the reflector which collects it. The reflector concentrates it on the boiler, which is a silver tube with blackened surface, placed in the focus of the reflector. Some radiation is necessarily lost at the reflector and some at the surface of the boiler, because perfect reflectors and perfect absorbers do not exist; but, when the distillation has been started and is in full running, the whole of the heat which penetrates the boiler is used in transforming water into steam, which is retransformed into water in the condenser and measured in the receiver. A portion of the heat of condensation is utilised in raising the feed water to the boiling temperature before entering the boiler.

The details of construction and the dimensions are fully set forth in the paper printed in the *Proceedings* of the Cambridge Philosophical Society. It will be sufficient here to give a brief summary. Fig. 1 shows a general view of the calorimeter mounted equatorially on a tripod. Fig. 2 shows the calorimeter in section. The sun's rays are collected by the reflector $B_1 B_2 B_3 B_4$, which consists of three conical mirrors, $B_1 B_4$, $B_2 B_3$ and $B_3 B_4$, so constructed that rays of light, parallel to the axis of the instrument O P, falling upon these mirrors are all reflected upon the length A B of the axis. A B is the *focal line* of the reflector. The mirrors are carried by arms, as shown, which are attached to the central tube C K. This tube, which is twelve inches long and has a diameter of two inches, is the condenser. It is connected by an india-rubber tube with the glass funnel Z, through which it is filled and by means of which the height of the water in the upper and narrower tube C A can be regulated. The portion A B of this tube is the boiler. It is of silver, blackened outside, and has a circumference of 37 millimetres. When the instrument is pointed to the sun all the rays which strike the mirrors are reflected upon this surface, which has an area of 18·8 square centimetres. The effective collecting area of the reflector is 904 square centimetres, so that the rays are concentrated 48 fold. The glass funnel Z is set so that the level of the water inside the calorimeter stands somewhere between E and F. F G H is a glass tube or dome which performs the functions of a water-gauge, a steam space and a means of watching the distilling operation with a view to being perfectly assured that there is no priming. The tube G L in the

[1] *Proceedings* of the Royal Society of Edinburgh, 1882, xi. 827.

[2] On a solar calorimeter used in Egypt at the total solar eclipse in 1882. By J. Y. Buchanan, F.R.S. *Proceedings* of the Cambridge Philosophical Society (1900), xi. pp. 37, 74.

axis of the instrument is the steam delivery tube. When everything was cold and the sun's rays were concentrated by the reflector on the tube A B, the water boiled in forty seconds. The steam rises in the glass dome, from which it finds exit through the tube G L. Condensation begins so soon as the steam has passed below the point B, and the water produced is collected at L in a graduated tube. After the distillation has been running for a certain time a considerable quantity of very hot water is collected at the upper part of the condenser, and it slowly rises through the narrow annular space B C to replace the water removed from the boiler by evaporation. The boiler is thus fed with water at the boiling temperature, and when the calorimeter has settled down into steady working, the whole of the heat which reaches the water from the sun is used in *transforming water at its boiling point into steam of the same temperature.* It is essential that the distillation be kept running continuously. If the meteorological conditions are such that the boiling is interrupted, then it is of no use making observations at all.

Locality.—Sohag, where the observations were made, lies on the left bank of the Nile, in lat. 26° 37′ N. The expedition

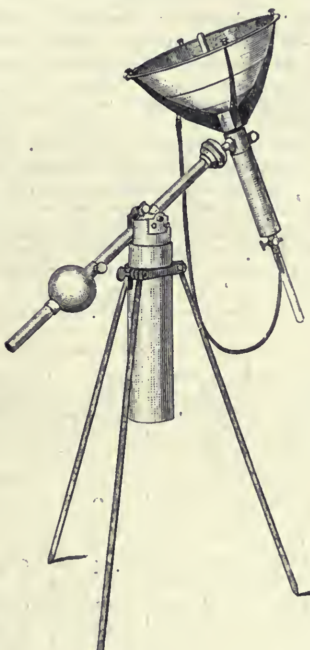

FIG. 1.

arrived there on May 8, 1882, and I was able to begin work on the 11th. As the instrument was new in every way, the work of the first few days was directed towards learning the manipulations and finding out and rectifying defects. Improvements of one kind or another were made every day up to the 15th. On the 16th, 17th and 18th experiments were carried out with the instrument in best working order, and under very favourable conditions. The sun's declination was 19° 22′ on the 17th, so that the mean meridian altitude during the three days was 82° 45′, corresponding to a zenith distance of 7° 15′. The following table gives the sun's zenith distance, as taken from the globe, at every half hour from noon to ± 4 hours, apparent time:—

Hours	0	0·5	1	1·5	2	2·5	3	3·5	4
⊙'s zenith distance	7°·25	10°·5	16°	22°·5	29°	36°	42°	49°	55°·5

The useful time for observation is from 9 a.m. to 3 p.m.

The principal object of the experiments was to ascertain the *maximum* rate of distillation under the most favourable circumstances. This occurred during the forenoon of May 18, when the meteorological conditions were as favourable as they could be. The sun shone steadily in a cloudless sky, and the air was motionless. The shade temperature reached 40°·5 C. in the course of the day.

Between 11h. 35m. 40s. and 11h. 39m. a.m., 5 cubic centimetres of water were distilled, being at the mean rate of 1·501 c.c. per minute at 11h. 37m. 20s. a.m. As the collecting area of the reflector is 904 square centimetres, this corresponds to 16·60 c.c. distilled per minute per square metre. At 11.37 a.m. the sun's zenith distance was 20°. Therefore we know that the sun's perpendicular rays, as received at or near the sea-level, have a heating effect sufficient to evaporate *more* than 16·6 c.c. of water per square metre per minute. Correcting this value for the obliquity of the sun's rays, by the method which shall be indicated presently, it becomes 17·04 c.c. per square metre per minute.

If we take the cubic centimetre of water to weigh one gramme and the latent heat of steam at 100° C. to be 535 gramme-degrees (grs.° C.), the evaporation of 17·04 c.c. water requires 9116 grs.° C. of heat; and this is the amount of heat in ordinary units per square metre per minute which can be collected from the rays of the vertical sun at the sea-level, and can be there utilised. Further, 9116 grs.° C. of heat are equivalent to 3875

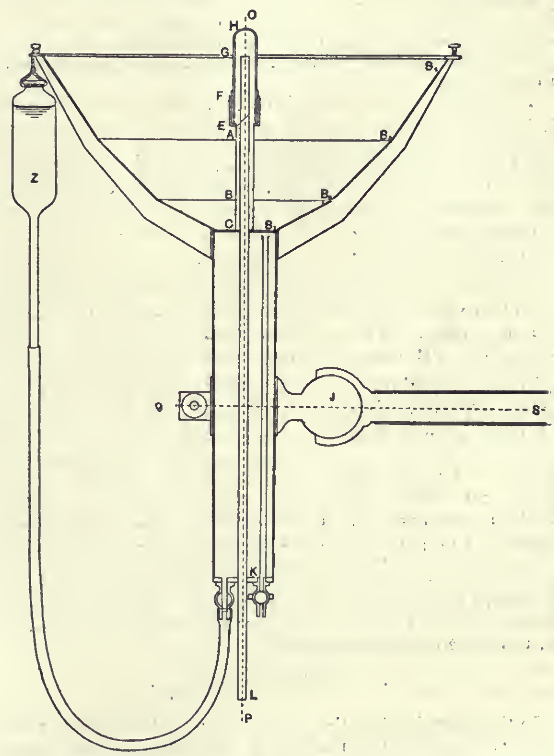

FIG. 2.

kilogramme-metres (kg.m.) of work, so that the working value of the sun's rays as collected by our calorimeter is 3875 kg.m. per minute, or 0·87 horse-power per square metre. No allowance has been made for instrumental imperfections. They certainly exist, but I do not think that more than ten per cent. need be allowed for them. If, however, we increase the working value of the sun's rays from 0·87 to 1·0 horse-power, the allowance is certainly sufficient; and this is probably very close to the true heating value of the sun's rays as they reach the sea-level. Taking the earth's mean distance from the sun's centre to be 212 times the radius of the sun, the radiation emitted by one square metre of the sun's surface is spread over, in round numbers, 45,000 square metres of the earth's surface. Therefore the intensity of the radiation of the sun's surface is equivalent to at least 45,000 horse-power per square metre. This figure, especially when used in connection with so very small a surface as one square metre, conveys no definite idea to the mind. The following consideration may assist in giving definition to our conception. The specific gravity of solid iron at ordinary terrestrial temperatures is about 7·5; therefore one cubic metre of it weighs at the earth's surface 7500 kilogrammes. Taking the force of solar gravity at the sun's surface to be twenty-eight times that

of terrestrial gravity at the earth's surface, one cubic metre of cold solid iron on the sun's surface would exercise a pressure of 210,000 kilogrammes. To lift this mass through one kilometre against solar gravity would involve the expenditure of 210×10^6 kg.m. of work: and if this amount of work were done in one minute, the engine employed would have to develop 46,667 horse-power.

Further, the heat which is equivalent to 210×10^6 kg.m. of work is 494,100 kilogramme-degrees (Kg.° C.). When iron is burned in oxygen so as to form the magnetic oxide, the heat evolved is given by the thermochemical equation

$$Fe_3 + O_4 = Fe_3O_4 + 264{\cdot}7 \text{ Kg.}^\circ \text{ C.}$$

Using this constant, we find that the mass of iron which by its combustion would furnish the above amount of heat, would weigh on the surface of the earth 313·5 kilogrammes, and would occupy a volume of 0·0418 cubic metre, or 1 square metre × 4·18 centimetres. Therefore the heat required could be produced by burning 4·18 centimetres of liquid iron on a hearth of 1 square metre per minute. With a supply of oxygen of high tension this would not seem to be an insurmountable task. This is put forward only as an illustration, and in no way as an explanation of the source of the heat of the sun.

With this caution, however, I should like to call attention to a coincidence.

The specific heat of Fe_3O_4 is 0·1678, and its molecular weight 232, whence the water value of the gr. molecule is 38·93 grs. The molecular heat of combination is 264,700 grs.° C. Dividing this number by 38·93 we get 6800° C. as the temperature of the Fe_3O_4 produced. Adding 273, we have 7073° C. as the absolute temperature which may be produced. In a recent work[1] Scheiner gives 7010° C. as the most probable effective absolute temperature of the sun.

Whilst the maximum value recorded by the calorimeter is the most important for the determination of the sun's heating power, the other values obtained are of use for testing the working of the instrument. The principal disturbing element is wind. During the forenoon of the 18th there was an almost complete absence of wind. We take the observations of that forenoon, neglecting those that show a diminution of intensity as noon is approached, because the sun's heating power cannot diminish as noon is approached. They are collected in the following table. In the first column *a* is the mean time corresponding to the mean rate of distillation under *d*. Under *b* we have the sun's zenith distance at this time, and under *c* the secant of this angle, so that $c = \sec b$. Under *d* are the mean rates of distillation, in c.c. per minute, for quantities of 20 c.c. collected. Under *e* are these rates reduced to their value per square metre per minute, $e = 11{\cdot}06\,d$. Under *f* we have the values of *e* corrected for the obliquity of the sun's rays. For this purpose the formula given by Herschel in his "Meteorology" is used.[2] It is, using the letters in our table,

$$e = f(\tfrac{3}{4})^c \text{ whence } f = \frac{e}{(\frac{3}{4})^c}.$$

In this equation $\frac{3}{4}$ is the transmission coefficient of the atmosphere; therefore *f* is really the solar constant expressed in cubic centimetres water evaporated per square metre per minute. Under *g* it is given in grs.° C. per square centimetre per minute, whence $g = 0{\cdot}0535f$. As we have assumed $\frac{3}{4}$ to be the transmission coefficient of the atmosphere, and have found the vertical intensity of the sun's rays outside of the atmosphere, we obtain at once its intensity at the sea-level $h = \frac{3}{4}f$. This is expressed in cubic centimetres water evaporated per square metre per minute, and it is practically unaffected by the value which we accept as the transmission coefficient of the atmosphere.

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
a.m.							
8.55	44°	1·390	1·264	13·97	24.57	1·314	16·38
9.12	39°	1·287	1·306	14·43	24·35	1·3^3	16·30
9.29	35°	1·221	1·326	14·65	24 06	1·287	16 11
10.39	20°	1·064	1·405	15·53	23·92	1·280	16·02
11.28	10°	1 015	1·447	16·00	24·16	1·293	16·18

[1] "Strahlung und Temperatur der Sonne." Von Dr. J. Scheiner, Leipzig, 1899, p. 39.

[2] "Meteorology," by Sir John Herschel, Bart., Edinburgh, 1861, p. 10.

The figures in this table show that the values of the heating effect of the rays of the vertical sun, deduced from observations made when the sun was at zenith distances ranging between 10° and 44°, are practically identical. This affords very strong evidence that the calorimeter is a trustworthy instrument.

Reverting to our maximum value with an allowance for instrumental imperfection, if we take one horse-power per square metre as the intensity of the rays of the vertical sun at the sea-level, their intensity outside of the atmosphere is 1·5 horse-power per square metre, using Herschel's value for the transmission coefficient. This is equivalent to 15,882 grs.° C. per square metre, or 1·588 grs.° C. per square centimetre per minute. In round numbers we obtain 1·6 for the value of the solar constant. While it is possible that this value may be a little too low, reasons are given in the paper for believing that the values commonly received, which lie between 3 and 5 grs.° C. per square centimetre per minute, are much exaggerated.

Observations made during the Eclipse on the morning of May 17, 1882.

The calorimeter was directed to the sun as soon as after totality as possible. At 8h. 34m. the sun was totally eclipsed; at 8.51 the calorimeter was directed to the sun, but no boiling took place. At 8.58 the water began to "sing"; at 9.1 it boiled; at 9.3 it was boiling briskly, but it was not till 9.17 that the first drop of distillate fell into the receiver. By 9.19·5 1 c.c. had passed, and between 9.21 and 9.29·5 5 c.c. passed.

The observations made at this time are collected in the following table. In the first column is the apparent solar time of each observation, in the second column is the volume of distillate collected at that time, in the third column is the mean date of collecting each portion, in the fourth column is the date stated in minutes after totality, in the fifth column is the average rate of distillation in c.c.'s per minute during the interval, and in the sixth column is the percentage of the sun's disc exposed.

Apparent solar time, A.M.	Cubic centims. collected	Mean date and interval, A.M.	Minutes from totality	Rate of distillation	Amount of sun's surface exposed
h. m. s.		h. m. s.		c.c. per min.	
8 34 0	0		0		0·000
9 1 0	0		27		0·329
9 17 0	0				
9 19 30	1	9 18 15	44	0·400	0·509
9 21 0	0				
9 29 30	5	9 25 15	51	0·589	0·609
9 36 5	10	9 32 47	58·5	0·759	0·703
9 40 55	15				
9 45 45	20	9 40 55	67	1·034	0·788
9 47 0	0				
9 51 15	5				
9 56 0	10	9 51 30	77·5	1·111	0·864
9 59 50	15				
10 4 5	20	10 0 0	86	1·237	0·924
10 5 0	0				
10 8 52	5				
10 14 35	11	10 9 45	96	1·146	0·987
10 18 40	16				
10 22 20	20	10 18 30	104·5	1·161	1·000

From this table we see that when distillation has begun, it increases at a much greater rate than the exposed sun's surface. This must be so in the early stages, because we see that it is not till 26 minutes after totality, and when already 33 per cent. of the sun's surface has been uncovered, that the water in the boiler boils, and it takes 16 minutes more before any distillate is collected. Even when 50 per cent. of the sun is exposed, the rate of distillation is only 0·4 c.c. per minute. After this more weight may be attached to the observations, but their numerical significance is not great. Still, they show that useful information could be obtained by arranging for making trustworthy observations during the progress of an eclipse.

In the case of a total eclipse there must be an interval during which the sun cannot keep steam, however large the reflector

may be and however great its concentrating power may be. We have seen that when exposed cold as soon as possible after the total phase of the eclipse, it was twenty-seven minutes after totality before the water boiled. One-third of the sun was then uncovered. It is, therefore, reasonable to suppose that, if the eclipse had happened at noon, so that the first half of it could have been utilised as well as the second half, the sun would have kept steam in the calorimeter, and it would have continued to distil until two-thirds of the sun's surface had been obscured. Then distillation, if it did not cease, would become so slow that its rate would have no value, and fifty-four minutes would elapse before one-third of the sun would again be uncovered, during which the calorimeter would get cold. During this interval *steam must be kept artificially*. This is very easy. The glass tube which forms the steam dome is attached to a metal collar which screws down on a washer. It can, therefore, be easily detached. If, then, the steam tube of the calorimeter be connected by means of an india-rubber tube with a flask in which water is kept boiling, steam can be passed through the calorimeter at the normal rate until it is judged suitable to expose it again to the sun. There is no difficulty about this.

Although quite insignificant as a natural phenomenon, an annular eclipse is better for calorimetric experiments than a total one. On November 11, 1901, there will be an annular eclipse visible in Ceylon. The annular phase will last over ten minutes, and, at its greatest, 0·875 of the sun's disc will be covered. It is fairly certain that the calorimeter used in 1882 would not keep steam through this phase, but a larger reflector might be used. It would be worth while to have a reflector of such a size that steam would certainly be kept through the whole eclipse, especially during the annular phase, when all the radiation is from the peripheral region. J. Y. BUCHANAN.

THE MINING STATISTICS OF THE WORLD.

It is impossible to imagine a more concise, more intelligible, or more inexpensive collection of comparative mineral statistics than is contained in the General Report on Mines and Quarries prepared by Dr. C. Le Neve Foster for the Home Office, and it would be difficult to find an editor possessing in a more marked degree the requisite technical knowledge, literary skill and critical acumen for the difficult task of abstracting and collating the heterogeneous official mineral statistics of foreign countries and of rendering them intelligible to the general reader. In many countries the statistics published are imperfect or antiquated. Nevertheless, as regards output, Dr. Le Neve Foster has succeeded in getting together a mass of figures which, in the case of the more important minerals, may certainly be regarded as trustworthy. He has brought into one focus a representation of the present position of the mining industries of the world, and has thus rendered it possible to comprehend the enormous development that has taken place within recent years. The statistics given are of the greatest importance from a commercial point of view. In the United Kingdom alone the value of the minerals raised in 1899 was 97,470,000*l.*, and the vast sums representing British capital invested in mines in all parts of the world will be readily appreciated. Some indication of the remarkable strides made by the mining industry during the past ten years is afforded by the following comparison of the world's output of metals in 1889 and in 1899:—

	1889 Metric Tons	1899 Metric Tons
Iron	26,000,000	39,136,000
Gold	182	477
Silver	3,900	5,445
Copper	266,000	507,000
Lead	549,000	676,000
Zinc	335,000	511,000
Tin	55,000	74,000

In 1899 the world produced 723,239,000 tons of coal, 16,755,000 tons of petroleum, and 12,890,000 tons of salt. Nearly one-third of the coal supply was furnished by the British Empire. The United States supplied nearly another third, and Germany more than a sixth. The remainder was contributed mainly by Austria-Hungary, France and Belgium. The coal production of the principal countries was as follows:—

	Metric tons.
United States	230,254,000
United Kingdom	223,627,000
German Empire	135,824,000
Austria-Hungary	37,562,000
France	31,218,000
Belgium	22,072,000
Japan	6,761,000
India	5,016,000
New South Wales	4,671,000
Canada	4,142,000
Spain	2,671,000
Transvaal	1,938,000

In 1889 the United States for the first time outstripped Great Britain as a coal-producing country. In twelve months the British increase was 18,000,000 tons, but that of the United States was 30,000,000 tons. This enormous increase is undoubtedly due to the extended use of coal-cutting machinery. In the United States 23 per cent. of the total output of coal was mined by machinery. Only a little more than 1½ per cent. of the output was so obtained in Great Britain. The path of progress is, therefore, clearly indicated to British colliery owners.

As gold producers the British possessions take the first place, and, thanks to the increased output of Canada and of Western Australia, the British Empire reached a total of 5,475,000 ounces, or more than one-third of the world's supply. One-fourth of the world's salt, and more than half of the tin, are produced by the British Empire. On the other hand, the production of copper, lead, petroleum, silver and zinc is small in comparison with the world's output. The magnitude of the petroleum industry is surprising in view of the fact that its growth has been within the last half of the nineteenth century. The chief producing countries were:—Russia with 8,340,000 tons, the United States with 7,247,000 tons, Austria-Hungary with 325,000 tons, Roumania with 313,000 tons, and the Dutch East Indies with 217,000 tons. The United States has had to cede to Russia the position it so long held as first in the production of petroleum.

In 1899 the Transvaal was the greatest gold-producing country of the world, the output representing a value of 16,273,000*l.* Owing to the war, detailed statistics for 1899 are not available. In Cape Colony the outbreak of the war in October caused a rapid decrease in the output of the coal mines, and eventually stopped nearly all of them. In Natal, again, coal-mining was interfered with, and no official report for 1899 has been received. In Rhodesia, on the other hand, gold-mining made remarkable progress. The output of gold was 65,304 ounces in 1899, whilst in the previous year it was 18,085 ounces. The mining prospects of the country are certainly very satisfactory, more especially as the search for coal is giving most promising results.

The copious references to original sources of information given by the editor in footnotes form a very valuable feature of the report. In this connection it is noticeable that in his capacity of juror at the Paris Exhibition Dr. Le Neve Foster has had access to numerous special reports which, but for his assiduity, would hardly have come to the knowledge of English engineers. The great development of the iron ore resources of Luxemburg during the last thirty-two years, for example, was clearly illustrated in a table shown at the Paris Exhibition. In 1868 the output of iron ore was 691,000 tons, whilst in 1899 it was 5,995,000 tons. At another place in the volume the latter figure is given as 6,014,000 tons, there being apparently a slight discrepancy between the figures obtained by the Home Department of the Grand Duchy and by the German Customs Union, of which Luxemburg forms part. The political classification of the various States is in several cases a matter of difficulty, and has been attended to by Dr. Le Neve Foster with scrupulous care. It is possible, however, that in dealing with Austria and Hungary under one heading, while Sweden and Norway are dealt with separately, he will cause offence to the ultra-patriotic Magyars. Since the compromise between the two States, renewable every ten years, was not renewed in 1897, the Union is merely personal through the Emperor and Apostolic King, and in order to make it evident that Hungary is not a vassal State, the official denomination of the Austro-Hungarian Monarchy is to be preferred to the term Austro-Hungarian Empire used in the report.

Although not so trustworthy as the figures relating to mineral output, the statistics of persons employed and of accidents in mines are quite as important. The number of persons employed at mineral workings in 1899 throughout the world amounted to 4,312,000, of which 1,635,000 were engaged in the British Empire. The United Kingdom headed the list with 862,000 persons. Then followed Germany with 527,000, the United States with 488,000, France with 302,000, Russia with 239,000, Austria-Hungary with 219,000, Belgium with 164,000, and Japan with 133,000. Prior to the war the late South African Republic employed 100,000 miners. It appears that the British Empire employs more than one-third of all the persons engaged in mining and quarrying in the world. It must, however, not be forgotten that published figures are far from being absolutely accurate, and those cited by Dr. Le Neve Foster are merely the best obtainable at the present time. As an example of inaccuracy, the official returns from Ceylon give 1,108,306 persons employed in 1898 in mining in that island. It is incredible that the mining industry of Ceylon, which is comparatively insignificant as regards output, should afford occupation to as many persons as are employed in mining in all the other countries of the British Empire put together. Such figures are utterly useless for calculating death rates, and have, consequently, been discarded. The standard adopted for death rates is the number of persons killed per 1000 employed, and a comparison of the figures in different countries affords a good idea of the relative safety of the miner's occupation. In Great Britain, in 1899, there were killed in coal mines 1·24, in other mines, 1·76, in quarries 1·19, and in all mines and quarries 1·26 per 1000 employed. For the British Empire the average was 1·27 for coal mines and 1·64 for metal mines, and for the world 1·83 for coal mines and 1·64 for gold mines. In foreign countries the average was 2·25 in coal mines. It is evident, therefore, mining is conducted in Great Britain with a far smaller risk of accident to the workers than in most other countries. This gratifying result is due in no small measure to the untiring efforts made to improve the conditions of mining by means of legislation and Government inspection.

BENNETT H. BROUGH.

THE MINERAL CONSTITUENTS OF DUST AND SOOT FROM VARIOUS SOURCES.[1]

NORDENSKJÖLD collected and described three different kinds of dust, one consisted of diatoms, a second of a siliceous and apparently felspathic sand, both from the surface of the ice in Greenland; while a third consisted of sooty-looking particles composed of elements invariably associated with iron meteorites and of uncommon occurrence in terrestrial matter, namely, besides metallic iron, cobalt, nickel, carbon, silicon and phosphorus. He concluded that it was meteoric matter showered down upon the earth, and that cosmic dust is falling imperceptibly and continually.

A great variety of mineral matters, including dust from various sources, having been examined spectrographically by the authors, they give an account of its composition. Specimens which fell from the clouds were compared with those from known terrestrial sources. The first comprised (1) solid matter forming the nuclei of hail-stones collected during a storm on April 14, 1897; (2) solid matter from hail and sleet collected during a heavy shower from 2.30 p m. to 3 o'clock on March 28, 1896; (3) pumice from the Krakatoa eruption of 1883. These were examined for Prof. J. P. O'Reilly, who had collected them. (4) Dust from a dish exposed on November 16 and 17, 1897, in the outskirts of Dublin; and other samples with a similar origin which had fallen into porcelain dishes placed on a grass-plat in a garden. Varieties of flue-dust, (4) from Crewe gas-works, (5) iron-works, (6) sulphuric acid works, and (7) copper-smelting works, (8) volcanic dust from three different sources, (9) soot from laundry, laboratory, kitchen and bedroom chimneys. Flue-dust is characterised by the larger proportions of lead, silver and copper than other varieties of dust and coal ashes contain. Nickel and manganese are notably present, but the most striking feature is the quantity of rubidium, gallium, indium and thallium in all samples. Volcanic dust shows the bands of lime and magnesia with strong spectra of the alkali metals, and these are evidently its leading basic constituents.

Soot is of variable composition, not so much with respect to the substances present as to the relative proportions of each in any two samples. Its larger proportion of lime distinguishes it from dust collected from the heavens. Nickel, manganese, copper, silver and lead are constant constituents. The presence of nickel is probably due to minute quantities of this element being disseminated in coal, which is first converted by the carbon monoxide produced in the fire into nickel tetracarbonyl, which is naturally volatile but subsequently becomes decomposed and nickel or nickel oxide is deposited.

Dust from the clouds, collected either by itself or in hail, snow, sleet or rain, exhibits a regularity in composition not seen in other varieties of dust. It contains, apparently, the same proportions of iron, nickel, calcium, copper, potassium and sodium. The chief difference occurs in dust suddenly precipitated in sleet, snow and hail, since lead is found in larger proportions in these, and particularly so in one specimen from sleet.

It is evident that the presence of nickel is not positive evidence that the dust from the clouds comes from other than a terrestrial source.

The dust which fell on November 16 and 17, 1897, with its similarity in composition to that of meteorites, its being attracted by the magnet and its appearance are quite in favour of its being of cosmic origin. On the other hand, in its composition it is unlike volcanic dust, flue-dust or soot.

[1] By Prof. W. N. Hartley, F.R.S., and Hugh Ramage. Abstract of a ead at a meeting of the Royal Society, February 21.

STUDIES IN VISUAL SENSATION.[1]

THE object of these studies is to frame if possible a scale of visual sensation analogous to, and in correlation with, a scale of physical luminosity. The method is the employment of rotating discs.

If a disc be divided into eleven concentric areas of equal width, of which the inner is all white and the outer all black, while the intervening areas have sectors giving a series of 10 per cent. increments of white, this gives on rotation a series of grey rings between the black and white; but they are of very unequal values for sensation. While the step from black to the darkest grey involves a large stride in sensation, seemingly almost half-way towards the white, that from white to the lightest grey is of no great amount.

A contrast effect is very noticeable. Each grey annulus, especially in the darker rings, is differentiated in sensation into a darker moiety where it adjoins a lighter ring, and a lighter moiety when it adjoins a darker ring. But although contrast introduces a factor which somewhat distracts the judgment, the disturbance is not sufficient to invalidate the conclusion that equal, or approximately equal, increments of stimulus produce increments of brightness which differ widely in value.

By the use of slit discs on Maxwell's method the proportions of white stimulus may be so adjusted as to give, say, three rings intervening between white and black which do give approximately equal sensation steps. It is somewhat difficult, however, to estimate their value, and contrast again introduces a disturbing element. We obtain only a first approximation to a scale of sensation. Taking the black employed (admittedly only a very dark grey and not an absolute black) as a zero, and calling the value of the white 100 per cent., both for sensation and stimulus, we have, on the arbitrary scale thus formed, the following percentages:—

	Sensation.		Stimulus.	
	Increment.	Sum.	Increment.	Sum.
Black ring	0	0	0	0
Dark grey	25	25	6·5	6·5
Mid grey	25	50	13·5	20
Light grey	25	75	27	47
White ring	25	100	53	100

Here the equal increments of sensation are correlated with increments of stimulus very nearly in geometrical progression.

By interpolation a smoothed curve can be drawn through the observed mid-point of 20 per cent. stimulus and translated on to a disc. But this does not give a smooth increase of sensation from black to white through intervening greys. The value of the mid-point is too high.

Experiments with smoothed curves show that a mid-point of

[1] Abstract of the Croonian Lecture delivered at the Royal Society on March 21 by Principal C. Lloyd Morgan, F.R.S.

12 per cent. gives an approximately even passage from black into white.

The discrepancy between the ring-grading and the smooth shading is shown to be probably due to the contrast effects before mentioned, of which a rough quantitative estimate can be given.

The curve through ·12 per cent. mid-point, with equal increments of sensation correlated with increments of sensation in geometrical progression, is accepted as affording an arbitrary and empirical scale for increase of brightness due to increase in physical luminosity.

Colours are dealt with and even shading is obtained from black into blue, and into red, orange, &c.; white into similar colours, and one colour into another—for example, red into blue through intervening shades of purple.

The luminosity of these colours is determined in terms of the arbitrary scale on Sir Wm. Abney's method; and the results, as deduced from the empirical curve, are compared with those directly observed by the method of shading in rotating discs.

For comparison, the results are given in terms of the mid-points of curves analogous to that for the shading of black into white:—

Mid-point Percentages.

	Deduced from luminosity.	Observed by method of shading.
Yellow on black	13·8 per cent.	13·5 per cent.
Orange „	18·6 „	18·0 „
Light blue „	19·7 „	19·0 „
Red „	23·6 „	23·0 „
Full blue „	29·5 „	28·0 „
White on full blue	24·7 „	25·0 „
„ red	30·6 „	30·0 „
Orange on full blue	35·4 „	36·0 „
Yellow on light blue	39·1 „	40·0 „
Red on full blue	43·0 „	44·0 „

If these results be accepted as giving a sufficiently close agreement, it follows, first, that for colour shading the percentages of stimulus required are dependent on the luminosity of the colours employed; and, secondly, that all the data obtained by the method of shading can be plotted on a single curve which exhibits the relation of stimulus to sensation in visual impressions.

If we assume that the black on the arbitrary scale has a value of 1·87474, and if this amount be added to the stimuli throughout the scale, so that the white becomes 101·87474, the mid-point 13·87474, and so on, the scale becomes, so far as stimulus is concerned, an absolute scale. And on this absolute scale of stimulus, the sensations, plus some undetermined constant, form an arithmetical series, while the stimuli which are in relation to them form a geometrical series. In other words, the addition of this constant to the summed increments of stimulus at any stage of the scale causes these summed increments to fall into line as the terms of a geometrical progression. The stimulus value of the mid-point on the absolute scale is the geometrical mean between the values of the extremers on the same scale. *On this assumption*, therefore, and *between these limits*, Weber's Law and Fechner's expression of it hold good.

Its validity beyond these limits is questionable. Dr. Waller has shown good reasons for believing that near the threshold of sensation the completed curve shows change of sign, and becomes sigmoidal. Apart from the evidence he adduces, some such assumption seems to be well nigh necessary if we are to attempt to give a complete curve, which, near the threshold of sensation, does not land us in the maze of difficulties arising from the asymptotic character of a wholly logarithmic curve.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. J. J. SUDBOROUGH, senior lecturer and demonstrator in chemistry of Nottingham University College, has been appointed professor of chemistry at the University College of Wales, Aberystwith.

RECENT gifts in aid of the funds of the McGill University, Montreal, amount to more than 42,000*l*. Of this sum, nearly one-third was provided by the chairman, Sir William C. Macdonald, who has already given over half a million sterling to the same institution. As the development of the University has recently been mainly on the lines of applied science and medicine, it is the faculty of arts which will mainly benefit by this new donation.

IN the Court of Appeal, on Monday, it was decided that School Boards cannot provide out of the rates for instruction in subjects prescribed by the Department of Science and Art, either in day schools or in evening continuation schools. It is thus declared illegal for a School Board to expend money out of a local rate for any purpose other than elementary education. In schools in which instruction is given in subjects such as those in the Science and Art Directory any assistance afforded to them must come from funds other than those provided by the rate-payers for primary education. As many School Boards have been providing instruction of this kind, it is evident that the decision accentuates the urgent need of an authority to describe the powers of the various bodies concerned with primary and secondary education.

THE Association of American Universities recently met at Chicago and discussed, among other topics, (1) inter-university migration of graduate students; (2) fellowship; and, (3) the examination for the degree of doctor of philosophy. From a report in *Science* we learn that with regard to the first topic it was considered desirable to promote by all possible means the inter-university migration of graduate students, to the end that they may come under the guidance of teachers of varying points of view, and so may receive the broadest possible introduction to their chosen field of study. As regards the question of fellowships, the opinion was expressed that it would be advisable to make some of the fellowships distinctly research fellowships, to be awarded only to students who had already taken the degree of doctor of philosophy, and who had, therefore, received their academic equipment for their life work. In discussing the best type of examination for the doctor's degree, it was held very emphatically that the practice which is growing up in American universities, especially in some of the departments dealing with natural science subjects, of permitting the candidate to pass his examination course by course, as is usual in undergraduate instruction, is a pernicious one, and one which stands in the way of the attainment of the best and broadest scholarship. It was held that the examination for the doctor's degree should, in all cases, be upon subjects and not upon courses of instruction, the underlying principle being that the courses of instruction which a graduate student attends are but a small part of the work which he is supposed to do in order to prepare himself for his examination.

MR. ANDREW CARNEGIE has presented to the Iron and Steel Institute thirty-two 1000-dollar Pittsburg, Bessemer and Lake Erie Railroad Company 5 per cent. debenture bonds, the income derived from which will be applied to awarding annually one or more research scholarships of such value as may appear expedient to the council of the Institute. The awards will be made on the recommendation of the council irrespectively of sex or nationality. Candidates, however, must be under thirty-five years of age, and application must be made on a special form to the secretary of the Institute before the end of April in every year. The scholarships will be tenable for one year, but the council will be at liberty to renew them for a further period if thought desirable instead of proceeding to new elections. The object of this scheme of scholarships is to enable students who have passed through a college curriculum, or have been trained in industrial establishments, to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. It is suggested that the National Physical Laboratory—on the governing body of which the Iron and Steel Institute is represented—would for many reasons be a very suitable establishment in which such researches could be carried out. There is, however, no restriction as to the place of research that may be selected, whether University, technical school, or works, the only absolute condition being that it shall be properly equipped for the prosecution of metallurgical investigations. The results of the researches are to be communicated to the Iron and Steel Institute in the form of a paper to be submitted to the annual general meeting of members. If the paper appears to the council to be sufficiently meritorious, the author will be awarded the Andrew Carnegie gold medal.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 7.—"Some Physical Properties of Nitric Acid Solutions." By V. H. Veley, F.R.S., and J. J. Manley, Daubeny Curator, Magdalen College, Oxford.

In continuation of their former investigations, the authors have studied the densities with especial reference to the contractions per unit mass, and also the refractive indices. The various experimental and instrumental errors are fully discussed, as also the several effects likely to be produced by the various substances with which the acid solutions of necessity came into contact. The results obtained for the physical properties are given in series of tables and compared with those calculated from various equations for straight lines; these show that the physical properties are discontinuous at points corresponding very approximately to the concentrations required for simple molecular combinations only of nitric acid and water. In the case of the contractions the best defined points of discontinuity correspond to the composition of the hydrates with 14, 7, 4, 3, 1·5 and 1 molecular proportions of water; in the case of the refractive indices, the most marked points correspond to the 14, 7 and 1·5 hydrates; a remarkable discontinuity at 95-100 per cent. concentration was also observed. These points of discontinuity, though to some degree, yet to another degree are ideal in that within the limits of 1 to 2 per cent. in the vicinity of such points there is a transition stage.

The values for μ are further expressed in terms both of Gladstone and Dale's and of Lorentz's formula, and it is shown that the values in neither case are constant, but decrease with increase of concentrations.

Anthropological Institute, March 12.—Prof. Haddon, F.R.S., in the chair.—Prof. Victor Horsley exhibited some trephined skulls from New Britain, and read a communication by Rev. J. A. Crump describing the methods employed by the natives and the objects aimed at. The operator is the medicine-man of the tribe, and he employs a flake of obsidian or piece of shell; with this he scrapes the exposed bone until a piece the size of half-a-crown is removed. As a rule the operation is resorted to in cases of fracture, and the mortality is about 80 per cent. In New Ireland, however, some forms of insanity, and even headache, are treated in the same way, and there are cases in which people have undergone the operation five times at various periods.—Mr. J. Gray read a paper on cephalometric instruments and cephalograms. An instrument was shown for taking head measurements, which was devised for field work and required no delicate adjustments. Two other instruments for obtaining diagrams of the contour of the head were also described, and head contours taken by them shown on the screen.—Prof. H. Louis described the "kingfisher" type of Malay kris, the handle of which resembles a kingfisher's head and beak; according to the Malay legend they were made in memory of a chief named Kingfisher, who invaded the peninsula from the Bugis Islands many centuries ago.

Zoological Society, March 19.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Mr. Sclater exhibited and made remarks on some specimens of mammals from the Protectorate of Uganda recently received from Sir Harry Johnston, K.C.B. Amongst them were a skin and bones of a chimpanzee, which, so far as was known, was the only complete specimen of this ape that had reached this country from Eastern Africa. Other interesting objects in the collection were flat skins of two apparently new antelopes of the genera Cobus and Cephalophus. Mr. Sclater also laid upon the table a small case of Lepidoptera collected in St. Lucia, West Indies, by Major A. H. Cowie, R.E.—Mr. Tegetmeier exhibited a very fine head of the sable antelope (*Hippotragus niger*) from Barotseland.—A communication was read from Dr. G. Stewardson Brady which contained descriptions of a collection of Ostracoda belonging to the Zoological Museum of Copenhagen, most of the species represented in it being new to science. The collection was very varied in character, embracing examples of both marine and freshwater species from widely different localities.—Dr. C. I. Forsyth Major read a paper on *Lemur mongoz* and *Lemur rubriventer*, in which he pointed out that the species of Lemur which was generally called *Lemur mongoz* had absolutely nothing to do with the Linnean species of that name, which had been based on the description and figure of Edwards in his "Gleanings." The only ascertained localities in which the true *Lemur mongoz*, L., occurred were the neighbourhood of the Bembatoka Bay (N.W. coast of Madagascar) and the two islands Anjuan and Mohilla of the Comoro group. The earliest available name for the usually so-called *Lemur mongoz*—a very variable species, spread over a great part of Madagascar—seemed to be *Lemur fuscus*, E. Geoffr. The two species, as indeed were all the species of the genus, were easily distinguishable by the characters of their skulls.—Dr. Forsyth Major also showed that *Lemur rubriventer*, I. Geoffr. (of which *Prosimia rufipes*, Gray, was a synonym), was not, as had been supposed, the female form of *L. nigerrimus*, Scl., but a very well-marked species. A peculiar feature of the skull was a huge pneumatic cavity in the palatal, which invaded the whole bottom of the orbit.—A communication was read from Mr. P. Cameron containing an account of the Hymenoptera collected in New Britain by Dr. Arthur Willey. Owing to the fact of the locality having been but little explored previously, most of the specimens represented in the collection belonged to new species.—Mr. G. A. Boulenger, F.R.S., described four new species of freshwater fishes discovered by Mr. F. W. Styan, at Ningpo, China.—Mr. F. E. Beddard, F.R.S., read a note upon Garnett's Galago (*Galago garnetti*), in which he pointed out that a spiny structure, nearly similar to that previously described on the wrist of *Hapalemur griseus*, was also present on the hind foot of this animal.

Mineralogical Society, March 19.—Prof. A. H. Church, F.R.S., president, in the chair.—Mr. H. L. Bowman read a paper on the micas, tourmaline and associated minerals occurring in pegmatite at Haddam Neck, Connecticut. The occurrence resembles that at Auburn, Maine. A peculiar pink fibrous mineral surrounding prisms of lepidolite is shown to be a variety of muscovite.—Mr. G. F. Herbert Smith discussed crystals of calaverite from the Cripple Creek District, Colorado. They are triclinic, but pseudo-monoclinic owing to twinning about an axis parallel to the edge of the prism zone. The two individuals are interpenetrant with no apparent plane of separation. The crystals are also twinned in the ordinary way. Quantitative analyses made by Mr. G. T. Prior show that the material is nearly pure telluride of gold, $AuTe_2$, with only about 1 per cent. of silver.—Mr. W. Barlow exhibited models to show arrangements for the chemical atoms of crystals in harmony with the symmetry. The models are composed of closely-packed india-rubber balls of various sizes, each ball representing a single atom. Boracite, boric acid and cassiterite were dealt with. The structure assigned to boracite suggests an explanation of the peculiar dimorphism of this substance discovered by Mallard, and that representing cassiterite shows the twinning of this mineral.

Entomological Society, March 20.—Mr. G. H. Verrall, vice-president, in the chair.—Mr. C. J. Watkins sent for exhibition a series of larch twigs illustrating the winter condition of *Coleophora laricella*, the special feature being the manner in which the cases of the larvæ assimilated in colour with the bark of the larch.—Mr. G. B. Routledge exhibited a specimen of *Hydrilla palustris* taken on the wing by Mr. J. E. Thwaytes near Carlisle in 1899—the first male taken in that district. He also exhibited specimens of *Bembidium schuppeli*, a rare beetle captured on the banks of the river Irthing.—Mr. R. McLachlan exhibited Trichopterous larva-cases of the form known as "*Helicopsyche*" from the Prony River, New Caledonia, sent to him by Mr. J. J. Walker, R.N. They were large and remarkable for the size of the individual sand-grains of which they were built up. These sand-grains, Mr. Walker informs him, were water-worn particles of the heavier minerals of the river bed, such as chrome, nickel and iron ores. It is possible that similar cases were alluded to by Hagen in the *Stett. Entom. Zeitung*, 1864, p. 129, from the Munich Museum.—Mr. G. T. Porritt exhibited specimens of an almost black form of *Acronycta menyanthidis* from Skipwith Common, near Selby, and, for comparison, specimens from the moors near Huddersfield. The chief interest in the exhibit consisted in the fact that in both the districts where the melanic *menyanthidis* occurred, melanism was not a common feature: whereas in the Huddersfield district, where only the pale form of *menyanthidis* was taken, melanism was a conspicuous feature in many species, even in, and close to, the grounds, where only pale *menyanthidis* could be found.—Mr. H. W. Andrews exhibited a female specimen of *Amphidasys betularia*, with hind wings aborted and scarcely developed, taken at Paul's Cray, Kent, in May, 1896.—In connection with an announcement that the County Council had under consideration the feasibility of stocking the London parks with butterflies, Mr. H. Rowland-Brown stated that according to the

latest observations thirty-nine species of Rhopalocera were recorded within, roughly speaking, a ten mile metropolitan limit, but that of these he only knew of *Pieris rapae*, *P. napi*, *Vanessa atalanta*, *V. urticae*, and perhaps one or two others which could strictly speaking be said to inhabit the metropolis itself. Mr. A. J. Chitty said that *Pieris brassicae* had occurred, and that he thought *Vanessa polychloros* might be added to the list of those open to experiment. Mr. G. H. Verrall advocated the introduction of tropical and other foreign species in the great conservatories of Kew, where, without danger to the plants, they would be objects of great beauty and attractiveness, and Mr. Merrifield, while recognising the difficulties arising from soil, climate and surroundings, expressed his belief that certain hardy species would successfully resist their bird enemies.

Royal Microscopical Society, March 20.—Mr. A. D. Michael, vice-president, in the chair.—Messrs. Staley and Co. sent for exhibition a Bausch and Lomb Camera Lucida. It was described in the *Journal* of the Society last December, and is intended for reproducing an object diagrammatically, natural size.—Mr. E. M. Nelson read a paper on the working aperture of objectives for the microscope, in which he showed that in recording delicate observations it was advisable to state the precise ratio of the utilised diameter of the objective to the full available aperture. He then proceeded to explain the different methods by which this ratio, which he termed the working ratio, or W.R., could be measured. Dr. Tatham confirmed Mr. Nelson's views in regard to the necessity for recording the working aperture of objectives, and expressed his appreciation of the value of the methods proposed by the author for obtaining this measurement.—A paper, by Mr. H. G. Madan, on a method of increasing the stability of quinidine as a mounting material, was read by Mr. Nelson in the absence of the author. Mr. Madan found that by keeping quinidine heated to a certain temperature for a considerable time it was converted into colloid quinidine, which condition it had retained for a year; but whether the tendency to revert to the crystalline form was entirely overcome, time alone could show. Mr. Karop said of all media, quinidine, on the whole, was the best yet discovered for mounting diatoms, but it was very troublesome on account of its tendency to crystallisation. He hoped the material prepared as suggested by Mr. Madan would be marketed.—Mr. Rousselet read a paper on some of the rotifera of Natal, by Hon. Thos. Kirkman, illustrated by mounted specimens shown under microscopes. Mr. Rousselet had appended a technical description of *Pterodina trilobata*, one of the rotifers mentioned in the paper, a mounted one of which was among those exhibited; an excellent drawing of this rotifer, by Mr. Dixon-Nuttall, was also shown.—Mr. W. H. Merrett read a paper on the metallography of iron and steel, demonstrating the subject by the exhibition of a large number of lantern-slides of sections of different classes of these metals under various conditions of hardness, stress, &c. The methods by which these sections had been prepared and polished were also explained.

Royal Meteorological Society, March 20.—Mr. W. H. Dines, president, in the chair.—Dr. Hugh Robert Mill delivered a lantern lecture on climate and the effects of climate. He remarked that climatology is as much a branch of geography as of meteorology, in fact more, for it not only deals with the distribution of atmospheric conditions over the earth's surface, which is a geographical question in itself, but all the varieties of climate that give individuality to different countries are produced by the disturbing or controlling influence of land forms. After making a few remarks on the principles of scientific photography and also calling attention to spurious photographs, the lecturer proceeded to distinguish between "weather" and "climate." Weather is the condition of the atmosphere at any moment with regard to wind, warmth, cloud, electricity and precipitation; whilst climate may fairly be called the average weather of a place. Dr. Mill then exhibited on the screen a large number of photographs which he had himself taken in many countries, in order to illustrate the peculiarities of climates in which heat, cold, wind and rain respectively predominate, showing how the varying conditions of climate created by the greater land forms are responded to by the various adjustments of minor land-forms and of plants, and how they are taken advantage of by man.

CAMBRIDGE.

Philosophical Society, March 4.—Prof. Macalister, president, in the chair.—The ossification and varieties of the occipital bone, by Prof. Macalister. These deviations from the normal type, which occur in one out of every four skulls, may be divided into two great groups, (1) those depending on variations in the union of the five elements of the squama, supra-occipital, interparietal right and left and pre-interparietals right and left; (2) the second group consists of the variations due to the development of new centres of ossification in the lambdoid suture.—On the fifth book of Euclid's elements, by Dr. M. J. M. Hill.—Exhibition of Mr. Graham Kerr's method of reconstructing objects from thin sections, by Mr. J. S. Budgett.—Note on the colour vision of the Eskimo, by Mr. W. H. R. Rivers. Ten men and eight women from Labrador were tested with Holmgren's wools and found to have normal colour vision. In naming colours a limited number of terms were used which were extensively modified by suffixes to express differences of shade and tint of colour. The language was exceptional in possessing names for green and blue which were as definite as those for red and yellow, but resembled most other primitive languages in having no word for brown.—Note on the influence of external conditions on the spore-formation of *Acrospeira mirabilis* (Berk. and Br.), by Mr. R. H. Biffen. Chlamydospores of this fungus sown on pea extract gave rise to a sterile mycelium; on Klebs' solution and 5 per cent. glucose or cane sugar to numbers of intercalary sporangia; on beer-wort to sporangia and chlamydospores; on chestnut extract to endoconidia and chlamydospores—the former being in the greatest abundance when the extract was most dilute. Sowings of the spore-balls gave very similar results, the chlamydospores being replaced by spore-balls except in the case of beer-wort, where "ascogonia" were formed. Intermediate forms between the loose spiral "ascogonia" and the closely coiled helices of the spore-balls could be raised by transferring the mycelium from chestnut extract to beer-wort. Increasing the rate of transpiration caused the chlamydospores to become smooth and thick-walled, while diminishing it caused them to become smooth and thin-walled, instead of being rather thick and warted. The envelope of the spore-balls instead of being a single layer became several layers thick on checking the rate of transpiration.—On a reserve carbohydrate, which produces mannose, from the bulb of *Lilium*, by Mr. J. Parkin. Besides starch, the bulbs of several species of the genus *Lilium* examined contain another reserve-carbohydrate which exists as a sort of mucilage in the cell-sap. The sugar obtained from it by hydrolysis with weak acid is *mannose*.—Notes on new and interesting plants from the Malay Peninsula, by Mr. R. H. Yapp. The only partially explored mountain ranges of this region possess a very rich flora, unaffected by the presence of introduced species such as form a marked feature of the vegetation of the inhabited districts of the plains. A number of the specimens exhibited (which were chiefly collected on one of these mountains) are probably new, and belong to various natural orders, chiefly among the gamopetalous Dicotyledons. An interesting and little known fact is the storage of large quantities of naturally filtered water in the hollow internodes of several species of bamboo. The paper concluded with a brief account of two curious epiphytic ferns, whose fleshy stems are tunnelled by galleries inhabited by ants; forming, in fact, living ants' nests.—The prevention of malaria, by Dr. J. W. W. Stephens. This paper, after a brief historical account of the discovery and the investigation of the malarial parasite, described the researches of Dr. Christophers and the author on the disease in several localities on the west coast of Africa. The result of the work there done leaves no doubt that malaria is avoidable under the conditions of life in West Africa.—On the effects of a magnetic field on the resistance of thin metallic films, by J. Patterson. A. C. Longden, in the *Physical Review*, xi, 2, 40, described a method of making standard high resistances from thin films of metals deposited on glass by means of the kathode discharge. He has shown that the resistance of these films is much greater than that calculated from the ordinary specific resistance of the metal. The author has made experiments to determine what effect a magnetic field would have on the resistance of a film deposited in this manner from a bismuth kathode. The results obtained show that the change of resistance in the magnetic field is entirely different from that of ordinary bismuth. A film of cobalt $1\cdot4 \times 1\cdot3$ cm. with a resistance of $682\cdot2$ ohms was made, but no change in a field of 27,500 lines could be detected.—On the theory of electric conduction through thin metallic films, by Prof. J. J. Thomson. The author applies the theory, developed by him in a report to the International Congress of Physics at Paris in 1900, to the case of electric conduction through thin metallic films. He shows that when the thickness of the film

becomes comparable with the mean free path of the negatively electrified corpuscles, which on that theory are supposed to carry the electric current, the specific resistance of the substance forming the film will increase, and how it is possible from measurements of this increase to approximate to the mean free path of the corpuscles. It is also shown that the effect of a magnetic field on the resistance decreases with the thickness of the film.

Paris.

Academy of Sciences, March 25.—M. Fouqué in the chair.—On the Egyptian metals. The presence of platinum among the characters of a hieroglyphic inscription, by M. Berthelot. A metallic box, covered with inscriptions, and dating from about 700 B.C., had a portion of one of its characters made of an alloy of platinum. The specimen was too small for a complete analysis, but from its behaviour towards aqua regia it appeared to be a native platinum, possibly obtained from the alluvial deposits of Nubia or the upper regions of the Nile valley.—On the electrochemical relations of the allotropic states of metals, especially of silver, by M. Berthelot. The thermochemical behaviour of the different allotropic modifications of silver rendered it probable that a definite electromotive force could be observed in a cell containing the metal in two different states as electrodes. On experiment, this was found to be the case, the direction of the current agreeing with the thermal sign of the heats of transformation.—On secondary radio-activity, by M. Henri Becquerel. The radiation from a radium salt consists of three parts, the first, very easily absorbed, and capable of being deviated by a magnetic field; the second, similar in its nature to the kathode rays; and the third, very penetrating, but not capable of deviation by a magnet. Experiments are described showing the differences in the power of exciting secondary radiation possessed by these three classes of rays.—The origin of thermal sulphurous waters. Sulphosilicates and oxysulphides derived from natural silicates, by M. Armand Gautier. An experimental study of the mode of production of sulphurous waters. Granite and other igneous rocks, when finely powdered andtreated with water at 250°–300° C. give a liquid identical in character with ordinary thermo-sulphurous waters, although of greater concentration.—On some new derivatives of dimethylamido-benzoylbenzoic acid, by MM. A. Haller and A. Guyot.—A correction of a preceding communication by M. de Jonquieres.—On a formula of M. Fredholm, by M. G. Mittag-Leffler.—M. Sabatier was elected a correspondent for the Section of Chemistry in the place of M. Haller, named a member of the Academy, and Mr. Davidson a correspondent for the Section of Geography and Navigation, in the place of the late M. A. David.—On the general expression of the rational fraction approximating to $(1+x)^m$, by M. H. Padé.—On the formation of nodal lines of sand or dust, by M. C. Maltézos. A suggestion as to the cause of formation of small sandy hillocks on the sea shore.—The specific heat of a gaseous mixture of bodies in chemical equilibrium, by M. A. Ponsot.—The theory of the Wimshurst machine without sectors, by M. Bordier.—On the measurement of the period of the waves used in wireless telegraphy, by M. C. Tissot. The period of the oscillator was measured by the method devised by Fedderson and improved by Décombe. The periods measured were between $0{\cdot}6 \times 10^{-6}$ and $1{\cdot}8 \times 10^{-6}$.—The Ritchie telautograph, by M. Brauer. This apparatus transmits handwriting continuously without the use of clockwork.—On induced radio-activity and gases rendered active by radium, by MM. P. Curie and A. Debierne. It has been shown in a previous communication that the radio-activity induced by radium salts is effected through the intervening air. It is now found that the nature and the pressure of the gas are without effect upon the phenomenon, but that if a high vacuum is kept up the second body is not affected. On leaving the apparatus for some time, the secondary radio-activity is again observed, and if the gases evolved are again pumped off they are found to be extremely active in spite of their small mass. Their activity is so great that the glass tube containing them becomes fluorescent, and is visible in the dark.—The direct production of X-rays in air, by M. A. Nodon. Under the simultaneous action of ultra violet rays and an electric field X-rays may be produced without the use of a Crookes' tube.—A method for determining atomic weights founded upon the law of transparency of matter for the X-rays, and the application of this to the atomic weight of indium, by M. L. Benoist. The action of hydrogen upon realgar and the inverse reaction. The influence of pressure and temperature, by M. H. Pelabon.—The heat of formation of acetals compared with that of isomeric compounds, by M. Marcel Delépine.—On the acidimetric value of the monosubstituted benzoic acids, by M. G. 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DIARY OF SOCIETIES.

THURSDAY, April 4.

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THURSDAY, APRIL 11, 1901.

OSTWALD'S INORGANIC CHEMISTRY.

Grundlinien der anorganischen Chemie. Von W. Ostwald. Pp. xix+795. (Leipzig: W. Engelmann, 1900.)

NOTWITHSTANDING the great advances that have been made during the past generation in our theoretical knowledge regarding solutions and chemical equilibrium in general, elementary inorganic chemistry is taught to-day much in the same manner as it was in the early seventies. The ordinary student at the end of his junior course has a very hazy knowledge of chemical facts, and scarcely a trace of chemical common-sense; but to make up for these deficiencies he knows all about atoms and molecules. If he is asked how he would convert, say, cadmium sulphate into cadmium chloride, he will doubtfully reply, "Treat the cadmium sulphate with hydrochloric acid"—this because he knows no general principles concerning the facts of chemistry. If, on the other hand, he is asked why hydrogen and chlorine combine, he will probably answer with confidence somewhat in these terms: "They combine on account of the mutual attraction exercised by the chlorine and hydrogen atoms." He does not see that he is merely restating the fact in terms of an hypothesis, and that the question, in our present state of knowledge, has, properly speaking, no answer. The "heuristically" trained student has a better knowledge of certain facts, but he is equally ignorant of general principles, and equally unable to distinguish between what is fact and what is theory. To him, as to the other, chemical symbols, formulæ, and combining weights are part and parcel of the atomic theory, instead of a convenient method of expressing actual facts—a method, it is true, arrived at through the atomic theory, but a method which would persist though the atomic theory were abandoned to-morrow.

When such a student continues his course so far as to study modern theoretical and physical chemistry, he is loth to part with his old ideas, which enabled him to explain everything so beautifully (although in some mysterious, unfortunate way they never seemed to help him much when he was asked anything about facts), so that example and precept, experiment and lecture, do little to change his general attitude of mind towards the science.

All this is, of course, not the fault of the student, but the fault of the teacher, or rather of the text-books. The time that the student can devote to chemistry is, as a rule, so limited that some sort of text-book is indispensable, and this the teacher is obliged to follow more or less closely if he is to avoid confusing the student. Now of the elementary text-book of chemistry it may be said, "plus cela change, plus c'est la même chose;" the theory is almost invariably put before the student in its ancient form long before he needs to know anything about it, and long before he has a sufficient command of facts and principles to understand its derivation or appreciate its importance. The idea that a student must know the atomic theory and the means by which the present system of atomic weights has been arrived at, before he is taught the quantitative use of chemical symbols and equations, is pretty much on a par with the idea that a child must know the derivation of the alphabet from Egyptian hieroglyphics before he can be taught to read. From practical experience of teaching on both systems, the present writer can say that the student may be made to use symbols and formulæ very early in his course without attaching to them any theoretical significance whatever, and that he then uses them more carefully and correctly, because they represent to him definite quantities of definite materials, and not intangible atoms and molecules with which he can juggle at pleasure.

What is wanted, then, is an elementary text-book of chemistry developed from the outset in accordance with our modern theoretical knowledge. This want Prof. Ostwald's book is intended to supply, and the eminence of the author as investigator, writer and teacher is a sufficient guarantee of interesting and instructive reading.

So far as general arrangement is concerned, the book differs in no important respects from other text-books in the systematic description of the elements and their chief compounds. Physical and theoretical matters, however, are made subservient to the descriptive work, and are introduced as occasion requires. Thus the gas-laws come under the heading of oxygen; chemical forces, molecular weight, partial pressure, mass action, chemical equilibrium and catalysis, under hydrogen. The phase-rule is introduced in connection with water, to receive further exemplification under chlorine, sulphur, &c. In the same chapter are also discussed combining weights, the atomic and molecular theories and the law of reaction. Thermochemical equations are taken up in connection with hydrogen peroxide, photochemical action under chlorine, and electrolysis under hydrochloric acid. Valency appears halfway through the book in connection with phosphorus, and the last chapter of all deals with the choice of combining weights and the periodic system of the elements. Atoms and molecules are conspicuously absent.

These examples show the plan of treatment adopted; theory is throughout properly subordinated to fact and clearly distinguished from it.

As an instance of the modern aspect presented by the descriptive work in detail we may take the following section, which treats of the soluble salts of bismuth.

"*Bismuthion.*—Bismuth forms one sort of elementary ion, the trivalent bismuthion $Bi^{\cdots}$. This is almost the only ion derived from bismuth, for the tendency of this metal to form complex ions is extremely small, only a few complex organic ions containing bismuth being known.

"Bismuthion is colourless and forms an extremely feeble base with hydroxyl. The phenomenon of hydrolysis is consequently so pronounced in bismuth salts that it can be used as a characteristic test for them. As the basic compounds formed in this way are very slightly soluble in water, the bismuth salts can be precipitated by merely diluting them with water: on addition of acid the precipitate is re-dissolved.

"The best known bismuth salt is the *nitrate*, which is obtained in the form of the hydrated crystals, $Bi(NO_3)_3,5H_2O$, when the solution of bismuth in nitric acid is crystallised. When water is poured over these crystals, a snow-white crystalline powder of basic nitrate,

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$Bi(OH)_2NO_3$, separates out. . . . The nitric acid which is liberated passes into solution, so that a portion of the bismuth salt can remain dissolved. There is thus in the solution a chemical equilibrium with respect to the precipitate of basic salt, which is characterised by the concentration of the hydroxyl ion of the water being reduced, by the hydrogen ion of the free acid, to such a value as corresponds with the solubility-product of the basic salt. . . .

"When sodium thiosulphate is added to bismuth salts, a clear solution is obtained, which slowly decomposes with deposition of bismuth sulphide. The solution probably contains the sodium salt of a complex bismuth-thiosulphuric acid ; for on addition of potassium salts, a very slightly soluble precipitate of $K_3Bi(S_2O_3)_3+H_2O$ separates out, which may be looked upon as the potassium salt of this acid. Although it is probable that we are here dealing with a complex bismuth ion, accurate investigations are still wanting. It has been proposed to use the precipitate, which is of a yellow colour, as a means of detecting and precipitating potassium."

It seems almost a pity that the author, having before him the problem of presenting the material in such a new light, should not have seen fit to depart entirely from the traditional arrangement and set out the whole matter as he himself thought best. As he tells us in the preface, his choice was deliberate, and was no doubt well-considered, but the limitation in adhering to the historical treatment makes itself felt here and there throughout the book. It is new wine in old bottles.

No teacher of chemistry who takes the slightest interest in his profession or in his science can afford to leave this book unread. For the first time he has laid before him a presentation of the facts of elementary chemistry from the standpoint of modern theory, written as only Ostwald could have written it, and compelling attention, whether the reader agrees with the author or not. We understand that an English translation of the work has been undertaken, so that the student also will soon have it at his disposal. J. W.

AN AMERICAN ZOOLOGICAL TEXT-BOOK.

Text-Book of Vertebrate Zoology. By. J. S. Kingsley. Pp. viii + 439. Illustrated. (London: George Bell and Sons, 1900.) Price 12*s*. net.

AMONG the multitude of text-books upon various branches of zoology, or on zoology as a whole, that it has been our fortune to peruse, there are few, if any, of which we can say that they contain so much information in a comparatively small space as is the case with the one before us. Nor is this all ; whereas many works of a kindred nature are written in such an extremely abstruse style, and are so overloaded with technicalities as to be well nigh unreadable by any but the most thorough-going and uncompromising biological student, the style of the present volume is so easy, and the technical terms are so carefully explained, that a reader with little or no previous knowledge of anatomy or zoology would readily comprehend the nature of the structures described.

We refer in this connection to structures rather than to animals, because vertebrate morphology, based upon embryology, forms a leading feature of the book, the whole of the first part of which, comprising considerably more than half of the text, is devoted to this section of the subject. A systematic survey of all the leading groups of vertebrates constitutes the second moiety. And since there are few works known to us in which these two great divisions of the subject receive such an equal share of attention, on this ground alone Prof. Kingsley's treatise has a decided advantage over many of its fellows. Neither are his descriptions confined to the vertebrates of the present day, their extinct predecessors receiving a considerable share of attention. The work is, therefore, thoroughly comprehensive in its scope ; and is, in fact, for the most part exactly what such a treatise should be. Although it by no means does away with the need for text-books dealing with the palæontological aspect of the subject, it serves to indicate that the day when the zoologist and palæontologist worked on separate lines is gone for ever.

In a very large number of instances those whose studies are chiefly devoted to the anatomical and embryological side of zoology fail to keep themselves abreast of modern views in regard to systematic classification. But this cannot be laid to the charge of the author of the present volume, who has adopted a thoroughly modern and up-to-date system of classification, as is especially noticeable in his treatment of the fishes and of that group of vertebrates typified by the lampreys and hag-fishes, for which a popular collective title is at present a desideratum. The division of mammals into Prototheria and Eutheria alone is also a feature in accord with modern ideas.

Indeed, not only is Prof. Kingsley thoroughly up-to-date as regards classification, but in one instance, at least, he is ahead of contemporary opinion. We refer to his treatment of that difficult subject, the classification of birds. In his preface the author states that

"he has been unable to recognise in the so-called orders of ornithologists groups of birds of more than family rank, while their families are equivalent to genera in the other classes of vertebrates."

Accordingly, we find the class Aves divided into four ordinal groups only, namely, the (1) Saururæ, as represented by Archæopteryx ; (2) Odontormæ, typified by Ichthyornis ; (3) Odontholcæ, containing Hesperornis ; and (4) Eurhipiduræ, including all living birds. While our sympathies are to a very great extent on the side of the author in this matter, we are by no means prepared to go the whole way with him in this sweeping change, and venture to think that in this, as in most other matters, a *via media* is to be found. Moreover, we feel sure that if all existing birds are to be included in a single ordinal group, there is not the slightest justification for separating the cretaceous toothed birds (Hesperornis and Ichthyornis) as separate groups from the mere fact that they retain teeth, and in one instance biconcave vertebræ.

But all this is, to a great extent, a matter of detail, from which we return to the consideration of the work as a whole.

On one point, and on one point only, we take leave to consider that the author is unsound, and this is in connection with nomenclature. As he tells us in his preface, he refuses to change well-known generic names on the ground of priority, because "these are the names of morphological literature." If systematic zoologists have,

practically unanimously, come to the conclusion that Molge, and not Triton, is, for example, the proper title of the newts, and morphologists refuse to accept the change, we can only say so much the worse for the morphologists.

As we have already said, great credit is due to Prof. Kingsley for the attention he has devoted to the systematic part of his subject, as his own special studies are mainly directed to the anatomical and embryological aspects. But in these days it is well nigh impossible for a man to gain sufficient knowledge of a section of a subject with which he is not thoroughly familiar as to avoid mistakes when writing on it. And it would have been better for the reader had the author invoked the aid of a few specialists to revise the proofs of the systematic section of the work. Many awkward "misprints" and other errors would thereby have been avoided.

Restricting our criticism in this respect to the chapter on mammals, we may call attention to quite a number of "misprints" between pp. 395 and 399, most of which will be self-apparent to those conversant with the subject. One of the most serious is *Choeropus* for *Choeropsis* (p. 398); the one name indicating a marsupial and the other a hippopotamus!

But there are more serious errors still. On p. 399 we are told, for instance, that among the fossil genera of antelopes are Cosoryx, Tragelaphus and Antidorcas; the second being the title of the existing bushbucks, or harnessed antelopes, and the third that of the springbuck, which is alluded to on the same page as *Gazella euchore*, Cosoryx being also mentioned higher up on the same page as a deer! Neither is it correct to say that the American deer form only a sub-genus of Cervus. Again (p. 400), the domesticated Indian cattle are not the typical representatives of Bibos, and, indeed, do not belong to that group at all; while the statement (p. 401) that mastodons occur in Africa is, so far as we are aware, not founded upon fact. Were we disposed to dwell upon them, many other errors of a kindred nature might be pointed out, but we pass on to the illustrations.

Such of the latter as relate to anatomical structures and the development of the embryo are far the most satisfactory, and serve their purpose well, although frequently not of a very high class from an artistic point of view. But when we turn to the figures of birds and mammals we are surprised that any publisher could have been found willing to print such ghastly productions. Perhaps the very worst amongst a hopelessly bad lot are those of a bird of paradise on p. 350, and of the Sumatran rhinoceros on p. 355. Smudgy daubs is a mild way of describing them; and in the present age of cheap photographic illustration, the appearance of such ill-executed caricatures in any book is nothing short of a disgrace to all concerned in its production.

As regards the palæontological aspects of the subject, we think the author is to be congratulated on the manner in which it is treated. Of course there will be errors—and the omission of any mention of Ophthalmosaurus when noticing the Ichthyosauria (p. 313) is one—but they are few and far between; and in the main the relations of the extinct to the living types are well explained.

Apparently the book has been previously published in America, and its reproduction in this country may be taken as an indication that it has met with a favourable reception in the land of its birth. In spite of the blemishes to which we have referred (and they are, after all, not very great), we have no hesitation in saying that Prof. Kingsley's little volume is worthy of a hearty welcome on this side of the Atlantic on the part of both teachers and pupils.

R. L.

POPULAR BIBLICAL STUDIES.

The Social Life of the Hebrews. By the Rev. Edward Day. The Semitic Series. Pp. 255. (London: John C. Nimmo, 1901.)

THE present volume is the second of a series published under the editorship of Prof. Craig, of the University of Michigan, with the object of presenting "in popularly scientific form" the results of recent researches in Semitic fields. Prof. Craig has laid down for the last two years an ambitious programme of the work to be done in his series, and has announced the titles of no less than thirteen books of the series, but up to the present time only two of them have appeared. The first, by Prof. Sayce, was devoted to the social life of the Babylonians and Assyrians, and was reviewed by us last year; the second, which has appeared this year, and with which we are concerned, deals with the manners and customs of the ancient Hebrews. Mr. Day has undertaken a subject of great interest and, at the same time, one of great difficulty, inasmuch as almost the only sources accessible are limited to the Books of the Old Testament.

The publication of the late Prof. Robertson Smith's "Kinship and Marriage" and "Religion of the Semites" marked a great advance in Semitic learning, and since that time all writers on the customs of the Hebrews have been in great measure indebted to these books. In the first part of his book Mr. Day summarises to a certain extent the main features of Prof. Robertson Smith's work, though with some serious omissions. The Clan, the Family and Sacrifice are dealt with in three short chapters, none too much space for such important subjects, though doubtless enough for a popular work, while the remainder of the first part treats of the Hebrews during the period of the Judges. But no explanation at all has been given of the significance of circumcision, either as a sacrificial rite or from its connection with the *hôthên* "wife's father"; and though this may be due to the fact that the book is a popular work, yet, on the same grounds, a good deal of the matter relating to the licentious temple worship and similar customs might have been omitted. More, too, might have been said with advantage on the subject of totemism, which is but briefly discussed. The difficult subject of the Hebrew idea of the immortality of the soul has, perhaps, been reserved for another volume of the series, but we should have been glad to see a little more space devoted to the popular beliefs concerning Sheol, which is only spoken of once. Some reference, also, might have been made to the stress laid by the Hebrews on the importance of posterity and of prolonging the family name, which thereby acquired a terrestrial immortality. The chapter on the conception of Yahweh towards the

end of the book is better thought out, and will suffice for the needs of a popular work.

A characteristic of the book to which we must take serious exception is the frequent omission of references to passages on which Mr. Day bases his deductions. It is not enough to say "suicide was not discountenanced" (p. 172); if the statement is to be fully accredited, all the arguments, with chapter and verse, should be given in full. Moreover, we cannot congratulate Mr. Day on his attempt to provide us with a translation superior to that of the Authorised Version of the words *'ăsereth d'bhârîm*, or of I. Sam. ii. 8; the former he renders by "the Ten Words," a most infelicitous choice of the meanings of *dâbhâr* open to him, while the latter is translated "He taketh the needy from the city-dump" (p. 144); surely the old English word "dunghill" is not too outspoken for a popular book? Again, we must protest against such barbarisms as "pled" for "pleaded" (p. 28); "demonic" for "demoniac" (p. 56); "a few nearby men" (p. 62); and "he was the power back of nature" (p. 88); or such a hybrid as "David ben Jesse" (p. 63). We could wish, too, that Mr. Day's thirst after "local colour" (p. 225) had not led him to describe Samson as "being peculiarly susceptible to female charms" (p. 53); or his labours as "deeds of a purely personal character, in which a man of great strength got a little needed exercise, and at the same time revenged himself upon his personal enemies" (p. 66); or to refer to the rich of Samaria as "wealthy nabobs" (p. 102). The use of modern colloquialisms is unpardonable in all descriptions of Biblical events, challenging, as they do, the classic English of the Authorised Version. What can be said in defence of the following: "It is probable that the star-gazing of the society belles of Jerusalem, a Babylonian importation, was, like similar attempts to acclimate (!) foreign cults, in the nature of a fad, as was charioteering in the capital in the days of Absalom and Adonijah" (p. 116), or, "It was a long way . . . from the city-dump to a seat among the nobles of the land; but Yahweh knew the way" (p. 151)? Moreover, we are not by any means convinced that the "modern picnic" (p. 45) is the survival of the ancient sacrificial feast, even with the limitation "though seldom of such an exclusive character." It is a great pity that Mr. Day has thought fit to include such colloquialisms as the above in a work on which he has evidently spent time and care. We think, however, that he has not made the most of his opportunities.

OUR BOOK SHELF.

The Table of British Strata. By Dr. H. Woodward and Mr. H. B. Woodward. (London: Dulau and Co., 1901.)

THIS table will be welcome to students and teachers, for the existing charts are now quite out of date. To compile such is a laborious and somewhat thankless task, for it is impossible to please every one; indeed, the authors admit that in two respects, retaining the Permian in the Palæozoic and placing the Wealden in the Jurassic, they "seek to assert general rather than individual opinion." As to the former, the question seems to be largely one of locality; but in the latter we should have preferred the conservative side, at any rate till better cause is shown for the change; especially since it has led to the virtual suppression of the Neocomian as a system. For the same reason we are glad to see the Tremadoc group left in the Cambrian system. The latter they allow to be an important geological system, though we should have liked to see the alternative title, "Primordial Silurian," entirely suppressed, for it is commemorative of nothing less than an unwarrantable usurpation. The authors include the Solva Beds of St. Davids with the Menevian, which no doubt is justified by the presence of Paradoxides; but in that case too small a thickness is assigned to the system, for this addition would make it at St. Davids over two thousand feet. Remembering its importance on the Continent, we should have ventured to exalt Rhætic, thin as it may be in Britain, to the dignity of a system, and we think that over much importance is conceded to the subdivisions of the Tertiary series. Are the Thanet Sands or the Oldhaven Beds—not to mention others—more important than the Lower Calcareous Grit or the Stonesfield Slate? Yet we find the former among Formations and the latter in Subdivisions. Does not the statement that the glacial deposits contain only derived fossils beg a disputed question? It would be well to add "slates" to the economic products of Charnwood, for the "honestone," which is mentioned, is very local. A notable feature is the recognition as formation of Torridonian, Uriconian, Dalradian and Lewisian in the Archæan rocks, though some objection may be taken to the third name, on the ground that as originally defined it was a much too heterogeneous assemblage, and we may doubt whether the Moine schists, having regard to their history, form a good type. These criticisms, however, affect only points of detail, and some may even regard them as excellences, while as to the general excellence of the table and its high value to students there cannot be the slightest question.

Differential and Integral Calculus for Beginners. By Edwin Edser, A.R.C.S. Pp. vi + 253. (London: Nelson and Sons, 1901.)

THIS is a book written to supply the wants of students in advanced physics who require some knowledge of the calculus to enable them to read treatises on physical science, but who have not time to devote to a thorough study of higher mathematics. It is the outcome of a series of articles printed some time ago in the pages of the *Practical Teacher*. Most of the text-books which have been written on the subject of the calculus treat it too fully, and deal with examples of too complex and difficult a character to be really suited to the needs of students, who chiefly want the calculus to enable them to understand the theory of comparatively simple experimental problems in mechanics and physics. The present little book is one of several that have been written in recent years with the object of supplying this want. The author has treated the subject in a very simple manner, and does not assume the reader to have more mathematical skill than is involved in a familiar knowledge of elementary algebra and geometry. The opening chapter deals with the elements of coordinate geometry, and explains the nature of the circular and exponential functions sufficiently to render it needless for the ordinary student to refer to other books. This is further ensured by the addition of an appendix dealing with trigonometrical ratios and formulæ. Two chapters are spent on the differentiation of simple and complex functions, two others on maxima and minima and expansions, and two more on simple integrations by direct and special methods. This is followed by a section devoted to applications to problems in geometry, mechanics and, more especially, in physics. The final chapters deal with double and triple integration and simple differential equations.

In general the book is well written, and suitable for beginners. A good feature is the introduction of several numerical problems. The subject in this way is more vividly brought to the student's mind than when the examples, as is ordinarily the case, begin and end in

mere symbols. The analytical working out of problems is given with unusual fulness. On the whole this is a distinct advantage to the beginner, though in some cases it has been a little overdone, as, for instance, on pages 190–193, where more than $2\frac{1}{2}$ pages are devoted to the analytical work of a triple integration. Each chapter contains several examples fully worked out, and concludes with a number of exercises to which the answers are appended.

The arrangement of the book is good, but the section dealing with real and imaginary quantities early in the book, and that on the hyperbolic functions towards the end, might have been omitted without much real loss to the beginner, and certainly the former section is introduced too early.

A mistake occurs on page 101 in reference to an application to alternating electrical currents. The arithmetical average has been confused with the square root of mean square, with the result that the statement made is incorrect.

Engineering Chemistry. A manual of Quantitative Chemical Analysis for the use of Students, Chemists and Engineers. Second Edition. By Thomas B. Stillman. Pp. 503. (Easton, Pa.: The Chemical Publishing Co., 1900.)

THIS work is intended to be placed in the hands of the student who is commencing quantitative analysis, and hence the first eleven exercises deal with general elementary determinations, after which he will take up that portion of the book which deals with his special requirements. Schemes are then given for the analysis of coal and coke, iron ores, water, both for sanitary and technical purposes, of coal, oil, producer and flue gases, iron and steel, cement, building materials, paper, soap, lubricating oils, paint and asphalt. On account of the wide scope of the book, the author has secured special articles from experts on blast furnace practice, boiler tests, carbon compounds of iron, practical photometry, electrical units and energy equivalents. As must necessarily be the case from the size of the book and the variety of subjects dealt with, the work is written in a very compressed style throughout, so much so, in fact, that it is scarcely a suitable work to put in the hands of "students commencing quantitative analysis." The large amount of practical information in it, however, will render it a useful work of reference for chemists engaged in engineering work. In some respects there is room for improvement. The superabundance of decimal places in numerical results, which is, unfortunately, characteristic of American technical literature, is very much in evidence. Thus in an analysis of water for technical purposes, the constituents of which, on account of their minuteness, are weighed with an accuracy of about two, or at the most three, significant figures, in the final statement of results no less than five places are given. An even more striking case is in the section on calorimetry, in which the water equivalent of a calorimeter is laboriously worked out to six significant figures, 203·460, the experimental result being casually given as 227·22. Another example is in the determination of the heating value of a gas, the result being expressed as 10726·7 B.T.U. per pound. The section on photometry is somewhat out of date, no mention being made of any standard of light other than the sperm candle. The chapter on pyrometry and many of the numerical data also require bringing up to date, many of the tables and calculations being based upon the weight of a litre of hydrogen taken as 0·08958. A noteworthy feature, and one adding considerably to the value of the book, is the introduction of a short bibliography at the end of each special chapter. It is curious to note that in some cases recent papers of importance are given as references, but ignored in the text. This is especially noticeable in the chapter on pyrometry.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Darwinism and Statecraft.

EVERY one who is interested in the bearing which the teaching of biology has to the affairs of the nation must have followed with interest not only this last work of Prof. Pearson, but also his many contributions to the subject of heredity. Very opportune, also, is Prof. Lankester's appeal in his review (March 21) to "the greatest in the land," for apart from the fact "that the crowd cannot guide itself in its blind impotence," it is being otherwise led by the hysterical nonsense of a halfpenny Press that is degrading journalism and the people by the substitution of bombastic ignorance and assertiveness for knowledge and real merit.

It seems to me that the statement in Prof. Pearson's book of what the British parent ought to say is just what he should not say, and that the implication in Prof. Perry's review that the development of the faculties ought to begin at the public schools is open to objection because such beginning can and ought to be made very much earlier. The statement which Prof. Pearson would have the parent say would be better if it were altered so that for "son" we should read "children," for surely we require thinking and observing daughters as well as sons; and, moreover, the statement seems to imply that the parent expects the public school or the University to teach his son to think and observe, whereas, if the parent did his duty, the most that he ought to expect of these institutions would be the further development of his children's thinking and observing powers, and not their initiation in these matters.

We need thinking men, it is true; but what is the nature and source of the early influences that makes or mars their careers before they will be brought into contact with the educational system that is to make them thinkers? Are we not on the wrong track when we talk of "making thinkers" or of "training men to think"? Remembering the nature of the child, rather it seems to me that we should be nearer a successful issue if we turned our energies in the direction of retaining and developing the thinking powers it naturally possesses. Any one who chooses to observe the development of a child's mind will, if he does not suppress its natural bent, convince himself that a child from three to five years of age possesses thinking powers of greater capacity than we are in the habit of crediting to it. One of the external evidences of a thoughtful mind is the asking of questions which bear definite and logical relations to each other; and this is precisely what an average child of that age, when talking to a person in sympathy with it, is persistently doing. It is not content with a flimsy and evasive answer, and how strong is its intellectual craving is manifested by its evident disappointment or display of temper when its ignorant parents impatiently curb its curiosity. It is very seldom that one finds a mother who has endeavoured to retain her child's thinking capacities. I was once present when the four-year-old little daughter of such a mother was making inquiries about the planet Venus, and after she had been informed that both Venus and the earth travelled round the sun and were illuminated by it she put the query, "Then if there were people on Venus our earth would look to them like Venus looks to us?" This question demonstrates that a child possesses thinking powers sufficiently vigorous to enable it to see the logical relationships of bodies to each other that would certainly do credit to many of its superiors in point of years. This is not an isolated instance, and my impression, derived from observation and from conversation with observant persons, is that the average child, if not suppressed, is capable of a quality of thinking that leads its elders, when they try to follow it, into an intellectual quagmire of inconsistency and absurdity from which they beat an inglorious retreat by angrily bidding it "not to ask silly questions." If they bid themselves not to give silly answers their request would be just. Let me give an instance of the intellectual stagnation upon which the children who will become the nation's men are being reared. I once heard a child ask its mother, "What makes the flowers grow?" Promptly came the answer, "Jesus!" No wonder when children's intellects are muddled with such unprovable assertions that they cease to think. I recall my

own younger days, and the questions I wanted answered: they were answered negatively as a rule, and those that were positively so never allowed me to reconcile them with the facts around me, and I have since learned that they were mostly perversions of the truth, designed to secure a theological end. Little wonder I ceased to think by the time I got to school, and it is a matter of surprise to me that the examination system which followed did not convert a state of abeyance into one of absolute destruction.

There is no need to "make" thinking men; they are born to us if we will but retain, develop and strengthen the qualities that every healthy average child possesses. But to do this we want, above all else, thoughtful, intelligent and well-informed women who, as mothers, will recognise their duties to the State and will endeavour to retain and train the natural qualities, physical and intellectual alike, of the children that are to become the nation's men and women. The old style of domestic wife and mother—an uninteresting, mechanical drudge or a gaudy doll—may have been good enough for our forefathers, but for us it means loss of national time and energy which, if utilised, can be converted into factors capable of retaining the supreme position that we are fast losing. Granting that the results of a mother's pernicious training can be remedied in later life, it is obviously waste of valuable energy, time and money to organise an elaborate system of education to undo that which ought never to have been done. And, therefore, I urge that our national progress depends very largely upon "the hand that rocks the cradle": if it rocks that with an intelligent purpose, it will be well with our future men; if not, then England, like Tyre, Venice and Rome, "whose greatnesses it has inherited," "must be led, through prouder eminence, to less pitied destruction."

G. P. MUDGE.

THE ROYAL LIBRARY AT NINEVEH.[1]

OUR readers who are in the position of being able to recall the "discovery" of Nineveh, which was announced between the years 1845 and 1854, will have no difficulty in remembering that the exhuming of colossal bulls and bas-reliefs from the site of the palace of the great kings of Nineveh was almost contemporaneous with the discovery of the means whereby the wedge-shaped characters, which were found cut upon them in long, symmetrical lines, could be read and understood. It was a coincidence of the most remarkable kind that the excavations at Nineveh yielded at that time such a large mass of new material for Rawlinson, Norris and Hincks to work upon, and it may be safely said that the correct information concerning Bible history which they succeeded in producing from it convinced the general public of the trustworthiness of Rawlinson's system of decipherment more effectually than his epoch-making translation of the inscription of Darius the Great, which was cut on the face of the now famous rock of Behistun, would ever have done. The bulls and colossal figures and bas-reliefs, which Sir Henry Layard drew out of their hiding places, appealed strongly to the popular imagination, which already at that time saw in them the prototypes of the mysterious figures that the prophets of the Hebrew god Yahwe saw in their visions, but for the scientific seeker after the knowledge of the long-lost cuneiform language they did little. It was soon recognised that the texts engraved upon them contained many duplicates, and also that they did little more than set forth, in stereotyped and vaunting phrases, the names and titles which the kings of the Second Assyrian Empire arrogated to themselves. But further examination of the smaller objects which were found in the ruins of the Assyrian palace at Nineveh resulted in the discovery of a large collection of "tiles," as they were first called, made of baked clay, which were inscribed with texts written in cuneiform with minute characters, and this "find" is, for cuneiform decipherment, probably the greatest which has ever been made. An investigation of these minutely written texts showed that they consisted of lists of cuneiform signs arranged on a definite plan, of lists of words and phrases, and of connected narratives, which might well come under the general description of "literature"; in fact, the thousands of tablets and fragments of tablets which had been sent home, without the least idea of their value having entered into the heads of those who found them, turned out to be neither more nor less than the fundamental matter upon which the whole of the great superstructure of Assyriology has been built. We now know of a certainty that, at the close of the eighth century before Christ, Sargon, king of Assyria, possessed a few tablets, the contents of which concerned the business of his kingdom, and that he kept these in a chamber in his palace. It seems also that his two successors, Sennacherib (B.C. 705–B.C. 681) and Esarhaddon (B.C. 681–B.C. 668), added other tablets to Sargon's, and that we may also regard the united collections of these great kings as the nucleus of the Royal Library at Nineveh.

The great literary king of Assyria was, however, Ashurbanipal, and it is to him that the world is indebted for whatever knowledge of the Assyrian and Sumerian language it possesses. This mighty hunter and warrior found time to take an interest in the welfare of the literature of his country, and he spared neither pains nor expense in the formation of his library and in making it to contain a truly representative collection of tablets. His interest was twofold, for he was anxious to preserve both the best works written in his own native Semitic language and those which had come down in a more or less fragmentary condition from the Sumerians, a mighty people who seem to have given to the Semitic inhabitants of Mesopotamia nearly all that they ever possessed in the way of literature. With this object in view he had copies of many of the great Sumerian literary compositions made, and to these he attached translations in Assyrian, arranged interlinearly, a fact which seems to indicate that the knowledge of Sumerian was disappearing from among his people when he began to reign. Literary compositions were, however, not the sole objects of his care, for he collected the materials necessary for learning and teaching both the Assyrian and Sumerian languages, and evidences of this are the important remains of the syllabaries, sign-lists, vocabularies, &c., compiled by his orders, which are now among the most precious possessions of our National Museum. Wherever rumour declared that a valuable document existed he sent scribes and messengers to take a copy, or copies, of it, and the accuracy of such copies is attested by the fact that defective or illegible words or passages in the archetype were generally indicated as such in the copy or copies made for Ashurbanipal.

The above preliminary remarks are sufficient to indicate the value of the thousands of baked clay tablets and fragments which were found at Nineveh; but it has for many years past been a problem of some magnitude to Assyriologists how best to make use of the mass of material which exists. It is manifestly impossible for every student of cuneiform to possess the time and means necessary for examining and copying texts from thousands of tablets, and besides, few students are sufficiently skilled in reading cuneiform from tablets to make it worth their while to devote months to the work.

The late Sir Henry Rawlinson made a noble attempt to lay before Assyriologists the best of the texts in his monumental publication entitled "The Cuneiform Inscriptions of Western Asia," but this work, after all, only contains a *selection* of the texts available, and at the time of publication no scholar possessed the knowledge necessary for arranging and classifying the various documents which existed among the remains of the works of the Royal Library at Nineveh. It must not be imagined

[1] "Catalogue of the Cuneiform Tablets in the Konyunjik Collection of the British Museum." By C. Bezold. 5 vols. Printed by order of the Trustees. (London, 1889–1900.)

that work of classification can ever become simple, for the greatest difficulty will be experienced for years to come in joining up the various fragments which go to form a complete tablet. At the sacking of Nineveh by the Medes, many of the tablets which were made and collected with such care by Ashurbanipal appear to have been wilfully broken, and fragments of them were scattered in all directions; some were destroyed by fire and others crushed into dust.

A visit to the Nineveh Gallery in the British Museum will explain the difficulty to the reader in a few minutes, for in the cases there will be seen exhibited several tablets, or large portions of tablets, which are composed entirely of little pieces which have been joined together by the skill of generations of students of Assyriology. There are examples in which three or four of the fragments which help to form a tablet have been brought home from Nineveh by three or four different "discoverers," and many tablets must remain imperfect until the pieces necessary to complete them have been brought home from the ruins of the great palace at Nineveh, *where they still lie* awaiting the spade of the excavator.

The work of publishing the texts from the Nineveh Library which was begun by Sir Henry Rawlinson was carried on by Norris and Smith, and at a later period a number of foreign scholars began to publish works which professed to give amended and correct versions of some of their copies; but all were unsatisfactory in a greater or lesser degree, because the groups of texts which were reproduced were incomplete. Every student felt that he had not got all the existing materials for his work before him, and that any result which he arrived at one day might be upset the next by the identification of a fragment hitherto unnoticed in the British Museum collections.

Matters went on in this fashion for some years, but at length the late Sir Henry Rawlinson took the matter up and brought before his fellow Trustees of the British Museum the bold suggestion that a complete catalogue of the Nineveh, or Konyunjik, Collection should be prepared under their direction and issued by them as a British Museum publication. There is no need to point out here the leading part which the Trustees of the British Museum have always taken in promoting the interests of Assyriology; but it may be said in passing that, but for their powerful aid in advocating the importance of the subject, and the publications of texts which they have issued, practically regardless of cost, that science could never have attained to the position it now occupies, and its progress would have been retarded for a generation. In accordance with their enlightened policy, the Trustees decided to print the proposed catalogue of tablets, and the bulky work which we now have before us is the result.

The "Catalogue of the Cuneiform Tablets in the Konyunjik Collection of the British Museum" was prepared by Dr. C. Bezold, who is now professor of Assyriology in the University of Heidelberg, and is the author of some other works on his special subject. The Catalogue fills five volumes, which were published in 1889, 1891, 1893, 1896 and 1899 respectively, and contains 1949 pages, large royal 8vo, of descriptions of tablets; 265 pages of "General Index"; 154 pages of "Index of Reference Numbers"; a Bibliography of 13 pages; a brief Introduction of some 18 pages, besides the lists of texts published in Rawlinson's great work, "The Cuneiform Inscriptions of Western Asia," and several pages of preliminary matter issued with each of the first four volumes. The plan adopted by Dr. Bezold is, first, to give the size of each tablet or fragment, and to state, if a fragment, its position in the tablet of which it once formed part, *i.e.* he tells the reader if the fragment belongs to the top, middle, or bottom part of the tablet. These remarks are followed by details concerning the style of writing, its state of preservation, and notes which will serve to identify it. Next we are usually told what the contents of the tablet are, but if this is not possible the general character of the inscription is clearly indicated; extracts from colophons, "catch-lines," &c., are often given in the original cuneiform, as well as many passages of importance from a linguistic or historical point of view. Last, but not by any means least in importance, Dr. Bezold tells us under the description of each document where the text has been published, or quoted, or referred to, or translated, so that up to the time of the publication of each volume the Catalogue was not only a guide to the tablets, but also to the published literature which related to it. At the end of each description we find given the number by which it is known in the registers of the British Museum.

An objection which will be made to the usefulness of the work is, that the tablets described are not arranged in classes, but this may fairly be met by referring the objector to the very full General Index, which we have already mentioned, and its headings and subheadings. Thus, under the heading "Letters" we have twenty-seven closely printed columns of numbers, in which the reader is told the number of nearly every letter and report catalogued in the work and the page where the description of each will be found; the subheadings state which letter refers to public and which to private affairs, and the groups are usually very well and clearly defined. With many subjects, however, the classification might have been carried much further, and the subheadings might have been multiplied with great benefit to every student of the Catalogue; on the other hand, the page numbers have nearly doubled the size of the Index, and might with advantage to him have been omitted so far as K numbers are concerned.

We think the decision to print the descriptions under the register numbers was a wise one, for beyond all doubt it has tended to advance the progress of Assyriology, and has materially aided students of Assyrian in both hemispheres; had it been decided to classify the tablets and fragments before printing, it is doubtful if Dr. Bezold's work would ever have seen the light.

The boundaries between astrology and astronomy, and magic and religion, and legend and history were so loosely defined by the Assyrian *savants* that the student of to-day is often sorely puzzled as to the class in which he should group certain documents, and experience shows that his doubts on the subject may be as far off from satisfaction five years hence as they are to-day.

In addition to the general contents of the volume described above, mention must be made of the twelve excellent plates, in which a number of cuneiform tablets and fragments, selected chiefly for their forms and philological importance, have been reproduced by a photographic process. With the help of these and the remarks which Dr. Bezold makes in his Introduction, the intelligent reader will have no difficulty in gaining a good general idea of the principal classes of tablets which are to be found in the Nineveh Collection, and of their appearance, and with care he may even make some progress in the difficult subject of palæography. It will surprise no one to learn that the student who has specialised in any one small branch of Assyriology will be able to pick holes in some parts of Dr. Bezold's work; but in a progressive science like Assyriology this can never be avoided, especially as the publication of the Catalogue extended over a period of ten or eleven years. In fact, Dr. Bezold has himself supplied, in the later volumes of his Catalogue, the information which has enabled others to modify some of his statements and descriptions in the early parts of his monumental publication.

The space at our disposal will not admit of any even approximately detailed account of the contents of Ashurbanipal's great Library, but a general indication of the

chief classes of literature preserved in it must be added here.

Of almost the first importance for us are the large official authentic annals which were drawn up under the personal supervision of the high officials of the king, from which we gain very full accounts of the military expeditions undertaken by Sargon II., Sennacherib, Esarhaddon, and Ashurbanipal, and of their building operations. Intimately connected with these were the letters, despatches and reports written chiefly by the king's officials in various parts of the country, who by this means kept him informed of the progress of events in the countries under their jurisdiction. This class of document is of peculiar interest, and being in many cases dated they often afford precise information about important matters.

Next in importance come the tablets which deal with chronography and chronology, and by means of the so-called "Eponym Canon" it is possible to fix with exactness the dates of events which took place from about B.C. 900 to B.C. 640.

The business side of Assyrian life is represented by a considerable number of "contracts," which relate to all the principal matters concerning the transfer for payment of human beings, and of property of all kinds.

A very large class of tablets deals with astrology, and provides innumerable examples of omens of all kinds; these prove that the warlike Assyrian must have lived in a state of almost abject fear of the various spirits and demons with whom he peopled heaven and earth. Every event which happened was construed as a portent, and the Assyrian astrologer must have spent most of his time in tabulating forecasts. Diseases were cured by means of incantations and magical formulæ, for all diseases, both of mind and body, were believed to arise through the evil influences of the stars; such influences could be diverted, however, by the use of certain herbs, plants, stones, and portions of the bodies of animals. The ghost, the "evil foot" at the door, the evil dream, the bite of a snake, the sting of a scorpion, were all treated in much the same way, *i.e.* by magical means. Two great series of incantations have been identified, and the rubrics of some of the texts reveal a depth of superstition in the mind of the Assyrian which seems almost incredible. The burning of magical figures made of clay, bitumen, honey, flour, bronze, or wood during the recital of magical formulæ was, of course, common, and it is quite clear, from the documents of this class, that the Assyrians thoroughly earned their name of "magicians and sorcerers." Curiously enough, the Library included large numbers of prayers, many of which contain expressions of lofty spiritual ideas, but these show at the same time that the Assyrian religion never freed itself from the shackles of the basest superstition. Many religious texts describe and contain instructions for the performance of important rites and ceremonies, and most minute instructions concerning the offering up of sacrifices, the festivals of the gods, the dress of the priests, &c.

The legendary lore of the Assyrians is of peculiar interest, for it has preserved the history of the Creation and the account of the Deluge, which were incorporated by the Jewish compilers of the Hebrew Bible in Babylon.

We have already spoken at some length of the syllabaries, sign-lists and vocabularies which Ashurbanipal had drawn up, with Sumerian renderings arranged interlinearly, and from a modern point of view these will probably be regarded as the most valuable section of his Library. Dr. Bezold's Catalogue represents a vast deal of time and patience and hard work, and he is to be congratulated on the completion of a long and laborious task. There is no doubt that it will stimulate many in the prosecution of their Assyrian studies, and that it will greatly facilitate the rejoining of fragments of tablets; it will also help an investigator of any given class of tablets to produce an edition of its texts, which may be regarded as final until the tablets which still lie buried under the palace ruins at Nineveh are brought home to Bloomsbury. The thanks of every student of Assyrian are due to the Trustees of the British Museum for the production of such a costly but useful Catalogue.

NAVAL BOILERS.

THE interim report of the Admiralty Committee upon "Modern Types of Boilers for Naval Purposes," recently published, has caused much discussion; but, up to the present, it appears to have satisfied nobody and not to help the Admiralty much to settle the grave question of the best boilers for the future in the Navy. It gives the views, which are not so mature as could be desired, of the mercantile marine engineers of which the committee was chiefly composed, the experience of whom, up to the date of the appointment of the committee, had evidently been limited to the discarded cylindrical boiler.

The committee were asked (1) whether they consider water-tube boilers more suitable than cylindrical boilers for naval purposes; (2) if so, whether the Belleville is the best type of water-tube boiler for H.M. Navy; and (3) for suggestions on the extent to which any particular type or types of boilers should be fitted in new vessels. The replies given in the report are that "a satisfactory type of water-tube boiler" would be more suitable than the cylindrical boiler; that the Belleville boiler is not the type of water-tube boiler best adapted to the requirements of H.M. Navy; that Belleville boilers be not fitted in any ships not yet ordered, nor in any ships recently ordered for which the work upon the boilers is not too far advanced; but that they be retained in all completed ships and in all ships under construction for which the work is so far advanced as to involve delay in completion if the boilers were to be altered. The committee state that they have had under consideration four types of large straight tube boilers which have been tried in war vessels, viz., the Babcock and Wilcox, the Niclausse, the Dürr, and the Yarrow large tube boiler; and they suggest that "if a type of water-tube boiler has to be decided on at once for use in the Navy," some or all of these be taken. They recommend that boilers of these types be made and experimented with at the earliest possible date; and they call attention to the practical objections that have been found to the construction and working of the Belleville boiler.

The committee make the important admission that when the Belleville boiler was introduced into the Navy they consider "there was justification for then regarding it as the most suitable type of water-tube boiler for the Navy."

The only naval engineer upon the committee concurred with the report except that he considered, although the Belleville boiler has certain undesirable features, "it is a good steam generator, which will give satisfactory results when it is kept in good order and worked with the required care and skill"; and he sees "no necessity for delaying the progress of ships which have been designed for Belleville boilers in order to substitute another type of boiler."

This report does not satisfy the parliamentary opponents of the Belleville boiler, who appear to object to water-tube boilers of all kinds, and to advocate a return to the cylindrical boiler. In spite of the great advance recently made in the designs of boilers of water-tube type, they argue that because early attempts to use water-tube boilers at sea were unsuccessful, it is hopeless to expect any good results from those now available. These opinions are not endorsed by engineers of wider experience, especially by the designers of machinery for warships, who understand better the relative advantages and disadvantages

of different types of boilers from the point of view of warship requirements.

The Admiralty do not get much guidance from the report, and we understand that they only intend to supersede the Belleville boilers by those of Babcock and Wilcox and of the Yarrow types in a few vessels recently ordered, for which the boilers have not yet been put in hand. They had previously arranged for one of the recent cruisers to be fitted with boilers of the Niclausse type. The experiments recommended by the committee will doubtless be carried out as quickly as possible, after which there may be sufficient data available for determining the policy of the future.

The committee's report is distinctly disappointing, and suggests that their experience and judgment were not sufficiently matured to give much value to an interim statement. They seem to have been impressed by the advantages of good water-tube boilers for naval purposes, and to have realised that an ideal water-tube boiler—which, however, has not yet been approached in practice—would be much better for the Navy than the old cylindrical boiler. When they have to choose the best of the types that are available, they name four which they have had under consideration and recommend early experiments with them, and there they leave the matter. Meanwhile, the construction of battleships and their machinery must go on, and the Admiralty engineers are in the difficult position of having to decide upon the boilers for them. This task is not rendered easier for the Admiralty in carrying on the work of the Navy, nor is any one helped in forming an opinion upon the best policy for the future by the fact that the objections to the Belleville boiler which are pointed out by the committee apply, in a greater or less degree, to others that might be substituted for it. One thing that appears certain is that whatever the defects of water-tube boilers may be, or may be thought to be, their advantages to a warship are sufficiently proved to make a return to cylindrical boilers in the fighting navies of the world extremely improbable.

FORESTRY IN GREAT BRITAIN.

It is probably known to most people that for the supply of our requirements in the matter of timber, as in that of foodstuffs, we depend largely upon imports from abroad. But it may be doubted if many beyond the comparatively few who have given special attention to the subject have realised the fact that the annual cost to the country of these imports amounts to somewhere about twenty-five millions of pounds. It has been often urged that it would be worth some trouble to prevent this large sum, or a portion of it, going out of the country, and it has been pointed out that a proper system of forest management would bring about this result. Of course, so long as the foreign supply is ample and the price of imported timber is less than that at which it is profitably produced at home, our markets will continue to absorb foreign produce as heretofore; but these conditions which have hitherto prevailed are, in the opinion of experts, not likely to continue. For some years past this and cognate questions have attracted considerable attention, as witness the writings of recent date noted below,[1] all of which are deserving of careful perusal. The burden of all of them may be summed up in the phrase cited by a writer in the *Times* of March 17, 1899. "'Cotton,' it is said on the other side of the Atlantic, 'was once called king; but King Cotton is a lesser potentate than King Timber must soon become.'" In other words, the world's demand for timber is outrunning the supply under present methods, and an appreciation of timber values is therefore setting in which is likely to be permanent and progressive. Cheap timber is probably a thing of the past in this country. To some such a declaration will only appeal as the old cry of "wolf," and they may argue that any scarcity of timber will be balanced by the substitution for it, in many cases, of other suitable products; and such substitution has, no doubt, in the past taken place, as, for example, in shipbuilding. But it must be remembered that facility of transport has by now led to inroads into the world's timber capital in practically every timber-producing region, and the ruthless destruction of virgin forest without attempt at regeneration has brought us now within measurable distance of the end of the natural supply; and, further, in recent years the applications of timber to other purposes than those of construction, as, for example, in the manufacture of wood-pulp, have made it an efficient substitute for other products, and thus the demands for it have been multiplied, and may be yet increased. In these circumstances, then, not from any sentimental ideas connected with the growing of timber at home, but from the standpoint of business principles, the question of the growing of timber in Great Britain to an extent which shall in some measure make us less dependent upon foreign supply is one which has now assumed practical importance.

That wood can be profitably grown in Great Britain, even under the unscientific methods now in operation, has been amply proved; that under a system of scientific management crops of timber could be raised to yield a certain and adequate return upon capital is demonstrable. What lies at the bottom of the absence of such crops in this country is want of appreciation, from land-owners down to the working forester, of the right principles upon which they can be grown. There is, speaking generally, no practice of scientific forestry in Great Britain. Other immediate causes there are which have contributed more or less to the neglect of scientific forestry in Britain, for instance, tenure of land, the claims of sport—this probably one of the most influential factors—the rating of woods, and so forth. These are obstacles, and no doubt will remain so, in the way of tree-planting; but assuredly were our landed proprietors, land-agents and foresters better instructed in the methods of growing timber and in the possibilities of remunerative crops, less would be heard of them as such. It is difficult to instil into those who have been brought up in other traditions the fact that trees which are to yield a crop of timber must be grown under rules as definite as those which govern the cultivation of ordinary agricultural crops, because the time which is required for the maturation of the crop and the securing of the final yield exceeds the lifetime of the individual. Yet it can only be when this fundamental fact has been realised that a supply of marketable home-grown timber will be available in Great Britain.

There are not, it is gratifying to note, wanting indications that already some proprietors, even the Government, are appreciating the necessity and the advantage of cultivating their woods upon rational lines. Working plans for the economical management of woods have been prepared and adopted upon estates of the Earl of Selborne in Hampshire—of which an account will be found in the *Transactions* of the Royal Scottish Arboricultural Society already cited—of the Duke of Bedford at Woburn, of Mr. Munro Ferguson at Raith and Novar, and in the Forest of Dean the Government has similarly arranged a working plan. These working plans, which are a novelty in the country, are worthy of study by those who own woodlands, for they indicate the method which ought to be followed upon every estate where it is desired to grow wood for profit. Hitherto proprietors who

[1] "Forest Management, with Suggestions for the Economic Treatment of Woodlands in the British Isles" (*Trans.* Surveyors Inst., 1900); "Canadian Trade with Great Britain" (*Contemp. Review*, Jan. 1900); "British Forestry and its Prospects" (*Trans.* Roy. Scot. Arbor. Soc., vol. xvi. part II, 1900); "Deficient Production of Timber in the World" (*Trans.* Eng. Arbor. Soc., vol. iv. part III, 1900); "Outlook for the World's Timber Supply." Report of a lecture by Dr. W. Schlich (*Journal of the Society of Arts*, March 1).

may have desired to cultivate their woods on scientific principles may have met with the difficulty of obtaining expert advice; but such a difficulty no longer exists, for there are in this country now retired forest-officers of the Indian service to whom proprietors may readily go for sound and safe guidance. At the same time we cannot hope that the cultivation of crops of timber in this country will attain the dimensions which it must do if it is to affect to an appreciable extent the market supply of timber until means for the acquisition of knowledge of scientific principles underlying it are available to those to whom woods belong and to those who have the direct management of the woods. Within the last decade several trustworthy text-books upon forestry have appeared, but our only school for instruction in forestry at the present time is that at Coopers Hill. Coopers Hill is, however, open only to entrants to the Indian Forest Service, and there is no institution in the country to which any one desiring a thorough acquaintance with the principles of forestry can go. Our Universities are now alive to the claims of agriculture as a subject of study, and agricultural colleges are being formed in different districts. How long will it be before the Universities recognise that forestry also is worthy of attention, or the agricultural colleges take up the subject in their curricula? It is matter of common knowledge that a committee appointed by the Secretary of State for India recently reported in favour of the transference to Cambridge of the forest-school from Coopers Hill. As yet, however, no action has been taken upon the recommendation. The Secretary of State may rest assured that such a transference would be a reform meeting with the hearty approval of men of science, and the presence at Cambridge of such a school would give an opportunity to undergraduates connected with the landed interest to obtain some acquaintance with a subject of intimate concern to them. The influence of this upon the prosperity of the country would ultimately be most beneficial. As has been said above, ignorance is the real cause of our present condition as a wood-growing country, and until systematic instruction is provided in some of our Universities or colleges there will be no great reformation in forestry practice, although there may be amelioration through the action of intelligent and far-seeing individual proprietors.

THE CONCRETIONS OF THE CONNECTICUT VALLEY.[1]

THE curiously-shaped concretions met with in the Champlain clays of the Connecticut Valley have for many years attracted attention. Indeed, so long ago as 1670 some specimens were sent to the Royal Society of London. A detailed description of them and of their mode of occurrence, illustrated by fourteen beautiful quarto plates, has now been issued by Mr. J. M. Arms Sheldon. Four principal types of concretions are met with; some are discs which call to mind the Kimeridge coal-money; some are cylindrical or club-like, one example (probably a compound one) being a little more than twenty-two inches long; others are botryoidal, and not a few are "queer little images" resembling "fishes, birds, ant-eaters, elephants, dogs, babies' feet," &c. (Fig. 1).

These occur in stratified river-drift clays, some of which are of a kind suitable for modelling, and some are more or less gritty. The most remarkable point is that "each clay bed has a form of concretion peculiar to itself," that is to say, the principal types are never found together. The author has seen "forty-eight specimens from one bed so similar it was impossible to tell one from another."

[1] "Concretions from the Champlain Clays of the Connecticut Valley." 4to. (Boston, 1900)

Compound forms occur, where, for instance, two or even three discs have coalesced or been joined together (Fig. 2); and intermediate stages of such examples, and of immature concretions of horse-shoe type, are met with.

These remarkable bodies occur along the planes of bedding in the clays, and the lines of stratification may sometimes be seen to run in unbroken continuity through concretion and clay. In composition they consist of argillaceous and somewhat sandy limestone with small amounts of iron-oxide, magnesia and manganese oxide. They contain from 42 to 56 per cent. of carbonate of lime, whereas the clay possesses but 2 or 3 per cent. The concretions spread out laterally in the clay, as if water holding carbonate of lime in solution made its way

FIG. 1.—An animal form of concretion.

along the planes of stratification; and unless in the case of tiny spheroidal concretions they are almost invariably flattened. No doubt they are due to the obscure process of segregation, whereby the mineral matter, tending to collect together, has been unable to assume definite crystallographic shape, but has concentrated itself in nodular form. Some of the concretions show evidence of concentric structure, but no appreciable nucleus has, as a rule, been seen, though it might have consisted of a particle of carbonate of lime. Evidently the concretionary process went on in a quiet way, but not always uninterruptedly, as indicated by the distinct stages of growth seen in some specimens. The shape of the concretions is held to be partly determined by the structure

FIG. 2.—A treble form of symmetrical concretion.

and composition of the matrix which holds it, and by the amount of carbon dioxide and other organic acids present.

The author concludes his work with a useful bibliography, wherein the well-known researches of De la Beche, and the observations of A. H. Green and others are mentioned; but we miss the name of Sedgwick, who, in 1835, brought the matter before the Geological Society of London. The author, however, does not enter into the general question of concretionary structures; his work is essentially local, but it will be none the less interesting to those who give attention to the subject.

H. B. W.

THE WILDFOWL OF SCOTLAND.[1]

THE possession of artistic talents of the exceptionally high order of those with which the author of the beautiful volume before us is endowed confers, it must be confessed, an advantage over his brother naturalists to whom such accomplishments are denied the value and importance of which it is almost impossible to over-estimate. Most naturalists who have to depend upon the labours of others to illustrate their works (and they are the great majority of their class) have but too often to deplore either the lifeless and "wooden" character of the sketches with which they are supplied, or, when higher things are attempted, the sacrifice of accuracy of detail to artistic effect. For, among at least a large percentage of professional zoological artists, the combination of lifelike posture with strict attention to details of form, colour and anatomy seems to be almost unattainable. An artist like Mr. Millais, on the other hand, who is well acquainted with the special characteristics of the animals he portrays, and is at the same time an accomplished landscape and animal painter, is enabled to combine zoological accuracy of detail with scenic effect in the happiest manner. And we have in consequence pictures of animal life which satisfy the professed naturalist in regard to fidelity, and likewise appeal with full strength to the connoisseur in art and the lover of the beautiful in nature.

In an earlier work, "A Breath from the Veldt," Mr. Millais gave us some startling, but apparently truthful, sketches of antelopes and vultures in their most active phases of movement; and in the present volume he has done the same for the British ducks and geese and certain other of our larger wild birds. Examples of the artist's power and originality in this style are displayed in the plate of a peregrine swooping down on a flight of frightened teal; in the one of wild geese arriving from the Arctic regions, where the figure in the foreground is a marvellous example of artistic skill in representing a bird in what seems an almost impossible attitude; and, again, in the plate of herons moving a party of wigeon; and also in the sketch of Loch Spynie at sunset, in which the whole scene is alive with bird-life. Equally bold and original are the sketches of flocks of wildfowl when raked by a shot in their midst; but we confess that such scenes of slaughter are much less to our taste than those of birds under more normal conditions, and we should have liked the coloured plate of a flying mallard far better had the bird been unwounded. Nor is the artist in any way less at home in his pictures of bird-life in repose or slow movement, of which the plates of mallards feeding, of wild geese throwing out sentinels, and of teal in "bunched and scattered formation" may be cited as charming and exquisite examples. As an example of illustration of this nature we reproduce, by permission of the publishers, the annexed text-figure of mallard feeding. The flight, too, of ducks and geese, as we shall have occasion to mention again, is a favourite subject with Mr. Millais; and as an example of the V-formation nothing can be better than the plate, entitled "brent and their satellites."

FIG. 1.—Mallard feeding in the shallows and on the mud. From "The Wildfowler in Scotland."

To those who have had no experience of wildfowl shooting in Scotland and the isles, nothing can be more wonderful than the profusion in which ducks and geese occur during winter in their favourite resorts; and few sights in the world can be more marvellous than the flocks of these birds when assembled in their thousands and tens of thousands. Most wonderful of all, perhaps, must be the arrival of wild geese from the Arctic regions. By rare good fortune, as he tells us, the author has on two occasions witnessed this marvellous sight. On the first occasion, in October, he writes:

"I heard the first 'honk' of the season coming from far away up in the vast expanse of the blue heaven. For a long time nothing could I see, until at last a tiny speck appeared in the sky as far as the eye could reach, and, watching it intently, I saw it grow into the form of a goose that was slowly descending in great spirals. This bird was followed at regular intervals by others of the tribe subdivided into little parties of from six to ten individuals. . . . The prime leader came down immediately above the Inch, and while she was preparing to alight there were still small companies evolving themselves from the blue expanse, until at last there must have been some fifteen hundred birds actually on the wing, all in process of descent, and all following one another at regular intervals. By and by, when the leading geese had settled, the parties at the rear seemed to straggle more, and longer intervals occurred between them; yet they kept coming in all day as I roamed round and about the lake, till by the evening, when I disturbed the company, there must have been between two and three thousand geese sitting on the island."

A keen and enthusiastic sportsman himself, Mr. Millais writes mainly for his brother sportsmen, and much of his work, apart from the illustrations, will be interesting to them and to them alone. And this being so, he has done well in alluding to the birds whose haunts and habits he describes so graphically by their English names alone. But the author may also lay claim to be regarded as a field-naturalist of no mean ability, and many of his observations with regard to the flight of ducks are not to be found in any of the ornithological works with which we are acquainted. Several of the more interesting of these observations are given in the appendix, which is specially devoted to the appearance on the water of the different British ducks and the localities they especially affect in Scotland, and is accordingly

[1] "The Wildfowler in Scotland." By J. G. Millais. Pp. xv + 167. Illustrated. (London: Longmans and Co., 1901.) Price 30s. net.

the section of most importance to the naturalist. The following passage, from p. 37, may be quoted as a good example of the closeness of the author's observations:—

"Most sportsmen," he writes, "will have noticed that duck when travelling prefer flying over water; even when passing from one sheet of water to another they will avoid the land if they can. This may be said to be a hard and fast rule with all the true diving ducks, but not with the surface feeders, such as mallard, wigeon and teal; for when they in their flight observe the waters for which they are heading, they are as likely as not to cut over large extents of land to reach their desired haven, especially if they have been much shot at at any given point on their usual water route."

The text-figures in the appendix are especially intended to illustrate the modes in which different species of duck rise from the water, and the formation they assume when in the air. One exhibits the manner in which mallard and teal "scoot" along the surface of the water in close phalanx before rising; a second (herewith reproduced) displays the "bunched" formation assumed by eiders when rising; while a third shows the swallow-like flight and linear formation so characteristic of the long-tailed duck.

FIG. 2.—Eiders rising and showing bunched formation. From "The Wildfowler in Scotland."

For many of the species referred to the author well says that the illustrations best display the manner in which they severally leave the water when alarmed. When illustrations are lacking, excellent descriptions are given, as witness the following:—

"Shovellers are easily recognised when they rise from a marsh by the rattling noise they make, and I have heard them designated as 'rattle-wings' in more than one locality. They ascend abruptly at first, and fly rather like wigeon, but more easily and gracefully. They are adepts at turning, and seem to enjoy in spring beating up and down for hours together over the marsh which they intend to make their summer home. They do not fly very high as a general rule."

With this quotation we take leave, regretfully, of what is in every respect a very charming book, acceptable alike to the lover of art, the sportsman and the naturalist, and forming a handsome addition to the works allowed a permanent place on the drawing-room or library table.

COOPERS HILL COLLEGE.

THE report on this institution by the body called, on the *lucus a non lucendo* principle, the "Board of Visitors," was published last week so shortly before the House of Commons adjourned for the Easter recess that there was not time to take any parliamentary action.

The day after we went to press a letter appeared in the *Times* from Colonel Pennycuick, the president of the College who preceded Colonel Ottley, from which we make the following extracts:—

Sir,—The final decision of the Secretary of State for India, after the inquiry promised in his letter to Sir William Anson, has now been announced, and has justified the opinion expressed by every one acquainted with the facts, that the inquiry in question would be a farce, the Board of Visitors, by whom the inquiry was conducted, being already committed to an opinion, and its own competence being one of the very questions on which an inquiry was most urgently required.

Lord George Hamilton's letter to Sir William Anson repeats the libels contained in his reply to the deputation which waited on him earlier in the year, that the college "is in such a condition that it must be either reformed or abolished," and that it is "a burden upon the Indian revenues." Both these statements, unless they have been justified by something that has happened since the end of 1899, are absolutely untrue. At that date the number of candidates for entrance far exceeded the number for whom accommodation was available; the standard of the entrance examination had been steadily raised during the three previous years, and was still further raised in 1900; the college accounts during the same years showed a handsome surplus of income over expenditure; and the reputation of its students for practical efficiency stood at the highest possible level; its associate's diploma was accepted by the Institution of Civil Engineers as equivalent to their own associate's examination, and this latter examination was passed, while still at the college, by many students who did not succeed in obtaining that diploma; every student who obtained the ordinary diploma of the college, and some who did not, obtained useful employment within a few months after leaving the college. When and whence arose the necessity for "reform or abolition" in an institution which eighteen months ago was producing such results as these?

In his reply to the deputation Lord George Hamilton stated that shortly after he came into office—*i.e.* in the end of 1895 or early in 1896—he "determined to reorganise" the college as an alternative to abolition. If he did, I can only say that he

kept this determination a most profound secret from the college authorities.

I had three personal interviews with him during 1896 and 1897, and neither then nor at any other time while I was president of the college did he give the smallest hint that any dissatisfaction was felt with its condition (except on financial grounds) or that anything in the shape of reorganisation was contemplated or desired; I challenge production of any official document pointing to the necessity for any reorganisation, or for any change beyond those slight alterations which are from time to time necessary in every living organism. A Minister would deserve impeachment who really held the views which Lord George Hamilton professes to have held in 1896, and took no steps to give effect to those views, but continued to speak, publicly and privately, in the highest praise of an institution with which he was in reality so profoundly dissatisfied.

The committee of 1895, to which Lord George Hamilton refers, and whose proceedings occupy so large a space in the Blue-book, did not deal at all with the question of efficiency nor with the teaching staff, but with the financial question alone, a question which at that time appeared somewhat pressing, but which has lost its interest in view of the increasing prosperity of the college during the years succeeding 1895; this latter fact is concealed in the Blue-book by the ingeniously simple process of giving the accounts only down to 1895 and suppressing those of the later years.

. . . . . .

The India Office have striven to represent the question at issue to be whether the personal interests of the professors concerned are to outweigh the interests of the public service. The real question is not this, but whether these latter interests require or justify the drastic changes which have been made.

With an experience of the Indian Public Works Department and of Coopers Hill considerably greater than that of the present president, I assert most positively that they do not, and am prepared to prove this assertion to the satisfaction of any unprejudiced authority. I believe that I could prove it to the satisfaction of the Secretary of State himself, if I could get at him without the intervention of a prejudiced board or of hostile officials.

It is hoped that some means will yet be found to prevent irreparable injury from being inflicted on an institution which has such a splendid history and has done such signal service to our Indian Empire as Coopers Hill.

Yours faithfully,

JOHN PENNYCUICK, Col. R.E. (late President R.I.E.C., Coopers Hill).

Camberley, April 2.

With regard to the Report itself, which contains the evidence taken by the Board of Visitors, we have received the following from a Correspondent.

After a good deal of pressure both from within and from without the Houses of Parliament, the Secretary of State for India agreed to hold an inquiry into the condition into which the Royal Indian Engineering College at Coopers Hill has fallen under the present *régime*. This inquiry was to be held by a more or less newly constituted body. Lord George Hamilton, however, declined to submit the question of the dismissal of seven of the professors and teachers to an independent body, but he offered to allow the Board of Visitors to hold an inquiry into the justice of the sentences they had themselves pronounced. Adopting the principle familiar to readers of "Through the Looking-Glass," the Secretary of State permits first the judgment and then the trial. On the same principle, the Board of Visitors, into whose competency it is perhaps the most important matter of all to inquire, having acted as judges, not to say executioners, now appear in the *rôle* of prosecuting counsel.

The duties of the Board of Visitors of Coopers Hill seem nowhere to be very clearly defined. But by all analogy the staff of the College should have the right to appeal to the Board, and such an appeal should be listened to with impartiality. The Blue-book issued on April 1, which contains the account of the inquiry, shows, however, the very reverse of a judicial spirit. One of the disadvantages of the method of sentence first and trial afterwards is that instead of making "the punishment fit the crime" it becomes imperative to make the crime fit the punishment, and this the Board of Visitors have most sedulously attempted. They evidently felt they must "save their face" at no matter what cost to the institution whose interests they are supposed to protect.

Throughout the inquiry the dismissed professors and teachers were subjected to a hostile examination which contrasts most strangely with the friendly tone adopted to the president of the College and to other members of the staff, except when the evidence of the latter tended in favour of their dismissed colleagues and against the proposals of the president. The inquiry was rendered nugatory by the rules laid down for its conduct by the India Office. It was ordered that the evidence of each member of the staff should be rigidly restricted to the effect of the proposed changes on the teaching of his own subject and on himself personally, thus preventing material evidence being given on many points of vital importance to the welfare of the College. The Board of Visitors further limited the oral evidence by restricting the staff to the answering of certain questions prepared by the Board. The aim of Sir Charles H. T. Crosthwaite, the chairman of the Board, was apparently to make each of the gentlemen dismissed admit that his retirement was for the benefit of the College. Evidence was continually ruled out because, in the opinion of the chairman, it was of a personal nature; yet Colonel Ottley was allowed to indulge in personalities to an almost unlimited extent.

Throughout the inquiry the Board made little or no attempt to decry the ability or the efficiency of the gentlemen concerned. That was an impossible line, but their attitude throughout was one of

> "Willing to wound, and yet afraid to strike,
> Just hint a fault, and hesitate dislike."

Evidence exists both in the report of the inquiry and elsewhere that some at least of the Board were unacquainted with the contents of the report contained in the first Blue-book, a report purporting to have been drawn up by themselves. This is possibly to be accounted for by the indecent haste with which that document was considered and signed. More than one member of the Board was unaware that he had recommended such wholesale dismissals. The chairman and Sir W. S. S. Bissett express ignorance of the recommendation of the Board that the professor of electrical engineering should teach chemistry and physics in addition to his own subject, and of the fact that this extraordinary arrangement has had the approval of Lord George Hamilton. The Board knew so little of the staff of the College that they inquired after an instructor who has been dead for some years.

A careful examination of the Blue-book and of the minutes of the evidence reveals a wholesale repudiation by the Board of its previous recommendations. They repudiate the time-table incorporated in the first Blue-book and recommended for adoption by themselves. Perhaps the rejection of this document is the wisest thing the Board has done. They repudiate their own arrangement for the teaching of physics and electrical engineering. They repudiate their own arrangement for the teaching of mathematics, and they repudiate their own arrangement for the teaching of engineering.

One of the saddest features of the whole inquiry is the persistent effort made by both the Board and the president to belittle the status of the College. Coopers Hill in the past has stood high amongst the few institutions for scientific education in this country. It has done a great public service to India, and the prestige attached to its name is highly valued by the Government *in* India. Yet throughout the inquiry the Board compare it to a school, or to a technical college. Sir William Preece finds its nearest analogy in a

Metropolitan polytechnic. Finally, the president is desirous of following the lines adopted at Woolwich and Sandhurst, oblivious of the fact that these are military institutions and that Coopers Hill is a civil scientific College. The proper arrangement for the conduct of such a college as Coopers Hill is, in the opinion of Colonel Ottley, that there should be no intercommunication among the staff, but that each member of the staff should communicate alone with the president. The danger of this system of private conferences as leading to misrepresentation is exemplified by the case of Prof. Hearson, whose private consultations with the president are presented in such an extraordinary light by Colonel Ottley (Blue-book, p. 54). It is probably due to this that Prof. Hearson has been dismissed, though the reason adduced by the president was that Dr. Brightmore was debarred from teaching hydraulics, "his strongest subject," because that subject had been allotted to Prof. Hearson. There is, however, conclusive evidence that both professors were desirous of effecting an interchange of work by which hydraulics would have been handed over to Dr. Brightmore. This evidence the Board of Visitors ignore. Another result of this plan of separate conferences has been shown during the past year. The College has been divided into a series of separate camps. Tempted by the secret offers of the president, some of the junior members of the staff have consented to supplant their seniors for the modern equivalent of a mess of pottage, which appears, in this instance, to be something under 100*l.* a year.

The only charge against the College which appears in the report—and if any other existed we may feel sure the Board of Visitors would have set it forth—is that certain of the telegraph men have been found to be unsatisfactory, and that in some respects the telegraph branch might be improved. No fault of any kind is found with the training of the engineering students, who form by far the larger part of what is essentially an engineering college.

The criticisms on the telegraph men, of whom there are about three a year, is contained in Appendix 12 of the Report, pp. 131–146; and Mr. Pitman, who writes therein, expressly states that his "object is not to unduly criticise the course of instruction at the Coopers Hill College, *which has supplied the Department with so many excellent officers*,[1] but to bring to the notice of the responsible authorities that it would be possible to greatly improve the course of instruction and turn out officers with a greater knowledge of the theory and practice of Indian telegraphy than they can now obtain." This report, which is obviously intended, not as an adverse criticism, but as a friendly suggestion to the staff for improvement in details, expressly states that all the physical laboratory work (for which Mr. Shields is responsible) is excellent.

We have searched the Blue-book in vain for evidence that the Board of Visitors have tried to discover whether any of the suggestions made have been adopted, though Mr. Shields does manage to tell them that those referring to his part of the work have been adopted as far as time permits. And yet Mr. Shields is sent away. We happen to know that it was absolutely necessary for the Board to get rid of Mr. Shields because his successor had already been appointed! and because, moreover, Colonel Ottley had informed that successor, in the interval between the dates of the correspondence between Sir Wm. Anson and Lord George Hamilton (which was published in the daily papers) and the beginning of the inquiry, that whatever happened his appointment was secure! The bias of the Board is further shown by their conducting no inquiry into the admittedly excellent electro-technical course taken by Mr. Shields with some of the third year students.

[1] The italics are ours.

The defects of the telegraph students are not due to this or that part of the course being capable of slight improvement, for it is cordially admitted that many of them are excellent officers. The real reasons are given on pp. 121, 122. The calibre of some of the men during recent years has been exceptionally low, and owing to a variety of circumstances the abler men have not chosen to take telegraph appointments. This year, however, the standard is higher, and unless the break in their work, caused by the extraordinary plan adopted by the India Office of dismissing half the staff in the middle of the session, has too disastrous an effect on the students, they should take a high place in the service.

So far, therefore, from the indictment being justified that the College must be reformed or abolished, we can confidently assert that very few colleges, if subjected to such a hostile criticism as has been applied to Coopers Hill both by the president and by the Board, could show so clean a record.

A grave injustice has been done, not only to the seven gentlemen dismissed, but to all those whose services are "for the present" retained and to all who take part in the higher education of the country. The Board of Visitors have dropped their plea of economy because the changes have been shown not to be economical. They have dropped their plea of increased efficiency because it is impossible to maintain that to dismiss a man with Prof. Hearson's reputation and to replace him by a man of the reputation of Dr. Brightmore (who has not hesitated to inform the Board that he is unable to maintain discipline in his class) makes for efficiency. The Board of Visitors have, in fact, no plea to put forward for the action they have taken. They have relinquished their powers of judgment to a military autocrat who, backed up by other retired officials at the India Office, has absolute power over the destinies of the entire staff at Coopers Hill. Recent events in this country have not increased the faith of the people in the ability of either our public offices or of our army officers. Military methods have been shown to be imperfect and the scientific and educated opinion of the country will be slow to recognise the advisability of extending them to such institutions as the Engineering College at Coopers Hill.

NOTES.

As already announced, a meeting of the International Association of Academies will be opened at Paris on Tuesday next, April 16, in the rooms of the Institute of France. The following is a list of delegates appointed to represent the various academies which will constitute the Association:—Amsterdam: Prof. H. G. van de Sande Bakhuysen, president of the physico-mathematical section of the Academy; Prof. H. Kern, president of the section of letters; Prof. J. de Goeje. Berlin: Prof. H. Diels and Prof. W. Waldeyer, permanent secretaries of the Prussian Royal Academy of Sciences; Prof. R. Helmert; Prof. J. H. van 't Hoff; Prof. T. Mommsen; Prof. E. Sachau. Brussels: Lieut.-General de Tilly; Prof. P. Fredericq. Budapest: Prof. C. Than; Prof. I. Goldziher. Christiania, not yet announced. Göttingen: Dr. E. Ehlers and Dr. F. Leo, secretaries of the Society; Prof. E. Riecke. Copenhagen: Prof. J. L. Heiberg; General G. Zachariæ. Leipzig: Prof. W. His; Prof. A. Fischer; Prof. H. Gelzer. London: Sir Michael Foster and Prof. A. W. Rücker, secretaries of the Royal Society; Dr. T. E. Thorpe, foreign secretary of the society; Sir Norman Lockyer; Sir Archibald Geikie; Prof. A. R. Forsyth; Prof. E. Ray Lankester; Prof. A. Schuster. Munich Prof. W. Dyck; Prof. F. Lindemann; Prof. K. Krumbacher. Paris, Academy of Inscriptions and Belles Lettres: Count De Lasteyrie, president; MM. P. Berger, vice-president;

H. Wallon, permanent secretary; L. Delisle; G. Boissier; Bréal; Barbier De Meynard; Senart; E. Müntz. Academy of Sciences: MM. Fouqué, president; Bouquet de la Grye, vice-president; Berthelot and Darboux, permanent secretaries; Marey; H. Poincaré; Moissan; Lannelongue. Academy of Moral and Political Sciences: Count de Franqueville, president; G. Picot, permanent secretary; Gréard; Glasson; Lachelier; Sorel; Boutroux. St. Petersburg: MM. Famintzin; Backlund; Oldenbourg; Kouliabko. Rome: Prof. S. Cannizzaro; Prof. A. Mosso; Prof. I. Guidi. Stockholm: Prof. G. Retzius, president of the Academy of Sciences. Washington: Prof. G. L. Goodale. Vienna: Prof. Victor von Lang, general secretary of the Academy of Sciences; Prof. T. Gomperz; Prof. Leopold von Schroeder; Prof. J. Karabacek; Prof. J. C. Zirecek; Prof. A. Rollett; Prof. G. Tschermak.

MR. L. DE NICÉVILLE, who has for many years been well known by his published work on Indian and Malay Lepidoptera, has been appointed entomologist in the Indian Museum, Calcutta.

PROF. EUGEN WARMING AND DR. VICTOR MADSEN have been appointed to the Danish Geological Survey, and Dr. H. Topsöe has retired from the Survey.

THE death from cholera of Mr. G. F. Reader, of the Geological Survey of India, took place at Madras on March 12. Mr. Reader was appointed as a specialist in coal mining in 1899, and for the last five months of his life also officiated as Government mining inspector.

REUTER'S correspondent at Constantinople states that the sharp earthquake experienced there on March 30 occurred at five minutes past nine in the morning. The movements observed were in the direction from south-west to north-east and lasted nearly five seconds.

MR. W B. TRIPP, writing from Isleworth, says that on April 4, about 10 p.m., a fine display was observed of lunar halo with horizontal ray on a level with moon and two paraselenæ (or mock moons) at its intersection with the halo, which remained all the evening while the paraselenæ soon disappeared.

THE subjects of the Walker prizes in natural history to be awarded by the Boston Society of Natural History, Massachusetts, U.S.A., are as follows:—For 1901: Monograph on any problem connected with, or any group belonging to, the North American fauna or flora; for 1902: (1) nuclear fusions in plants; (2) the fate of specific areas of the germ of chordates, as determined by local destruction; (3) the reactions of organisms to solutions, considered from the standpoint of the chemical theory of dissociation.

AN International Maritime Congress will be held at Monaco on April 12–15, under the presidency of M. J. Charles-Roux. The congress will discuss, among other questions, those of assistance to the shipwrecked, the international unification of coast-lights and buoyage, maritime meteorological observations, wireless telegraphy, marine pigeon-post, international maritime tribunals, and a scheme for the creation of a permanent international maritime bureau. The last-named project aims at the international discussion of maritime questions by a permanent and official body.

THE Director of the Missouri Botanic Garden has recently called attention to the facilities offered by that institution for botanical research. The garden owes its foundation to the munificence of Henry Shaw, and the good work which he inaugurated has resulted in the formation of a splendid collection of plants in the garden and in the herbarium, together with an adequate library without which they would lose much of their value. The collection of books is especially rich in systematic works, and thus affords opportunities for study of the American flora and of its relations with that of other countries. The Director, Dr. Trelease, extends also a courteous invitation to those who may desire to make use of the collections for physiological or other objects, suggesting that provision may be made to suit the requirements of those who desire to engage in such investigations. The growing prominence which is being given to research, and the spirit which impels it, affords one of the surest guarantees for greatness of the intellectual and material future which lies before a strong and virile community.

THE Brussels Academy of Sciences announces the following prize subjects for 1901:—New researches upon the compounds formed by the halogens between themselves (800 francs); the determination of the form of the principal terms introduced into the formulæ of nutation in obliquity and longitude by the elasticity of the earth's crust (800 francs); historical and critical discussion of Weber's experiments on unipolar induction, and new experiments bearing upon the laws and interpretation of this physical fact (800 francs); a contribution to the study of mixed forms with a number of series of variables, and the application of the results to the geometry of space (600 francs); history of researches on the variation of latitude, and a discussion of the interpretations of this phenomenon (600 francs); investigations of the physiological *rôle* of albuminoid substances in the nutrition of animals or plants (800 francs); new researches on the organisation and development of Phoronis, and the relations existing between the animals Rhabdopleura and Cephalodiscus, and the class to which the name Enteropneusta has been applied (1000 francs); description of simple substances, sulphates and binary compounds of Belgian soil (800 francs); researches on the influence of external factors on karyokinesis and cellular divisions in plants (800 francs).

THE expeditions which will start for the Arctic regions during 1901 are described in the U.S. *Monthly Weather Review* as follows:—(1) The Zeigler-Baldwin, to be led by Mr. Evelyn B. Baldwin, who lately resigned from the Weather Bureau for this purpose, the funds to be contributed by Mr. William Ziegler, of New York. (2) A Russian expedition, commanded by Vice-Admiral Makaroff, in a vessel constructed to push its way through ice fourteen feet thick. (3) A Canadian expedition, in charge of Captain Bernier, in the *Scottish King*. (4) A German expedition, plans not yet published. (5) A joint expedition by Dr. Nansen and the Duke of the Abruzzi. (6) Peary and his companions will finish the exploration of Grinnell Land and return home. (7) Dr. Robert Stein and his companions will complete the exploration of Ellesmere Land. (8) A relief expedition to Franz Josef Land, under the command of Captain Stoekken, and apparently at the joint expense of Nansen and Abruzzi. (9) Baron Toll will send a party from the Kara Sea eastward along the Siberian coast. Captain J. E. Bernier, of Quebec, proposes to travel by the route taken by the wreck of the *Jeannette*, with dogs, reindeers, and sledges, over the ice from the Lena or Bennett Island region. The trip may last two and a half years.

ON Tuesday next, April 16, Dr. Allan Macfadyen will deliver the first of a course of six lectures at the Royal Institution on cellular physiology, with special reference to the enzymes and ferments. On Thursday, April 18, Mr. Roger Fry will begin a course of two lectures on naturalism in Italian painting, and on Saturday, April 20, Mr. John Young Buchanan will deliver the first of a course of three lectures on climate: its causes and its effects. The Friday evening discourse on April 19 will be delivered by Prof. J. J. Thomson, his subject being "The Existence of Bodies smaller than Atoms."

THE dispute between the London United Tramways Company and the authorities of Kew Observatory has at last been settled. The tests made at the Board of Trade trial, referred to in our issue of March 21 (p. 499), having shown that the electrical working of the tramway from Hammersmith to Kew will interfere with the magnetic work done at the Observatory, the Tramways Company have agreed to pay a considerable sum towards the cost of removing the instruments to some more suitable site. The electric cars have in the meantime started running. The cars, which are much superior to the old horse trams in comfort, run smoothly and rapidly, taking about five and twenty minutes over the journey from Hammersmith to Kew. The overhead wires, though they certainly do not improve the appearance of the street, cannot be said to be excessively ugly; even at Young's Corner, Chiswick, where the branch line runs off to Shepherd's Bush, and where, consequently, the number of wires is considerable, the effect is not so bad as to be an eyesore. The route, leading direct to Kew Gardens, is a popular one with Londoners anxious to get into the country, and they seem already to appreciate the benefit of the electric trams; it is to be hoped that the system will undergo rapid expansion and extension and give Londoners a cheap, quick and easy method of getting really out of the town.

WE have received a copy of *Traction and Transmission*, a monthly supplement to *Engineering*, which makes its first appearance this month. Although the multiplication of technical journals is not a thing to be indiscriminately encouraged, the possibility of keeping pace with all the modern papers becoming daily more difficult to the engineer, there can be no doubt there is ample room at the present time for a magazine devoted to these subjects. England has been at last obliged to set itself seriously to the consideration of the means of relieving the overcrowding and congestion of traffic in the large towns, and the appearance of this paper, at a moment when the attention of every one is being directed to big schemes for traction and the transmission of power, is therefore very opportune. The first number, which is almost wholly devoted to electric traction, contains, amongst many others of great interest, articles on the standardisation of electrical apparatus, by Mr. H. F. Parshall, on the conveyance of goods on electric trolley lines, by Mr. A. H. Gilbings, and on the much vexed question of the education of the electrical engineer, by Mr. R. A. Raworth. The paper is got up in sumptuous style, being printed in very large type on extra thick paper and illustrated by a number of capitally-executed plates and diagrams.

THE U.S. *Monthly Weather Review* for December last contains the report of an interesting investigation by Dr. O. L. Fassig on the relation between summer and winter temperatures, with the view of finding, for instance, whether an extremely hot summer precedes a cold winter. The basis of the investigation was an accurate daily record of weather from 1817 to the present time. The investigation shows that neither warm nor cold summers have any more relation to the succeeding winter temperatures than the normal summers have, and that, generally speaking, there is no regular alternation or period in atmospheric temperatures.

The Summary of the Weekly Weather Report for the year 1900, published by the Meteorological Council, contains the mean values of rainfall and temperature for the principal wheat-producing and grazing districts of the British Islands for each five years of the thirty-five yearly period, from 1866 to 1900. The rainfall for the British Islands generally in the year 1900 was 3·7 inches above the average for the whole period. The greatest excess was 16·3 inches in the west of Scotland; in the north of Scotland the excess was 10·2 inches, and in the south of Ireland 7·9 inches. The only districts in which there was a deficit were the east and south of England, being 1·3 inch in both cases. The driest year, for the whole kingdom, was 1887 (25·8 inches), and the wettest 1872 (49·1 inches). The mean temperature during 1900 was, on the whole, 0°·4 in excess of the average, the greatest departures being +1° in the east and south of England. The coldest year was 1879 (46°·2) and the warmest 1868 (50°·4) for the British islands generally.

AT South Pasadena, California, the large reflector shown in the accompanying illustration, from the *Scientific American*, has been erected, and the solar rays concentrated by it are utilised to produce steam in a boiler at 150 lbs. pressure and drive a motor of fifteen horse-power. The reflector is 36 feet 6 inches in diameter at the top and 15 feet at the lower part. The inner surface is made up of nearly eighteen hundred small mirrors, all arranged to bring the sun's rays to one focus, at which spot a boiler 13 feet 6 inches in length and holding one hundred gallons of water is suspended. The reflector is mounted upon the same principle as that adopted for large telescopes, and is kept facing

the sun by a driving clock. The steam from the boiler is carried to the engine by means of a flexible phosphor-bronze tube, and returns from the condenser to the boiler, so that the water supply in the boiler is kept up automatically. The temperature at the focus of the reflector is sufficient to melt copper, and a pole of wood thrust into it burns like a match. The motor is used to pump water from a well and appears to work satisfactorily. As the skies of Southern California are remarkably free from clouds, and millions of square miles of arid lands are only awaiting the flow of water to be converted into fertile tracks, the solar motor may provide a practicable means for pumping the water and thus leading to the development of the country.

FOR sixty-seven years the Royal Observatory of Belgium has published an *Annuaire* dealing both with astronomy and meteorology, but from the present year each of these services has its own *Annuaire*. Twenty years ago M. Houzeau made a separation of these sciences, so far as the *Annales* are concerned; the division is now complete in everything except the administration. The *Annuaire Meteorologique* for 1901 contains a large

amount of useful information, including the average mean temperature and the mean maximum and minimum temperature at Brussels (or Uccle) for each day of the year, and the monthly means and extremes of all the principal meteorological elements since 1833. There are several articles of special interest, including one by M. J. Vincent on the history of meteorology in Belgium from the earliest times until the establishment of the Academy of Sciences at Brussels in 1773. The next *Annuaire* will continue the sketch from the creation of the Academy until the foundation of the Royal Observatory in 1833.

THE Committee of the Bristol Museum record in their annual report the extensive operations carried on at Brislington, near Bristol, where the remains of a Roman villa have been found. The extensive foundation walls of the villa were laid bare, showing the plan of its construction and many of its domestic features. In addition to two fine mosaic pavements, a great variety of relics of the Roman period were discovered.

THE "Physical Geography of the Texas Region," by Mr. Robert T. Hill, forms Folio 3 of the Topographic Atlas of the United States, issued by the U.S. Geological Survey (1900). It is a finely-printed work, illustrated with numerous maps and beautiful photographic representations of topographic forms, mountains, plains and scarps, rivers and canyons. In the descriptive text the author deals, for the most part, concisely with his subject, showing, first of all, the relations between the geological formations and the scenery, and then describing the principal features.

THE Maryland Geological Survey, which is under the direction of Dr. Wm. Bullock Clark, has just commenced the issue of a series of reports on the physical features of the counties of Maryland. The first report on Allegany County may be taken as a sample of what can be done by an energetic and well-equipped staff. It occupies 323 pages, is printed in remarkably clear type, and is illustrated with numerous diagrams, pictorial views and maps. Accompanying it is a folio atlas, with a colour-printed geological map on a scale of 1 inch to a mile, and other topographic maps. Many experts aid in the descriptions of various subjects, such as physiography, stratigraphy, mineral resources, soils, climate, hydrography, forestry, and fauna and flora. The county, indeed, is one highly favoured, few regions being more salubrious or more picturesque. Along its full length from east to west the Potomac River meanders through a district of rich farming lands and wild mountain scenery. Silurian, Devonian, Carboniferous, Permian and Pleistocene formations are met with, and the history of research among these strata is fully recorded. The leading characters and many details concerning the formations are given, though with too scant particulars of the fossils to please those who seek comparisons with equivalent strata elsewhere. The rocks grouped as Permian follow the Carboniferous conformably. They comprise shales and limestones with unimportant sandstones and coal-beds, and their fossils have yet to be described. To those residing in Allegany County this admirable memoir cannot fail to be of the greatest interest and service.

THOSE who have visited the Bankfield Museum at Halifax are aware of the improvements effected in the ethnographical section by the untiring industry of Mr. H. Ling Roth, the honorary curator, who has, in addition, just issued a pamphlet on the Fijian Collection. This excellent little guide of twenty-seven pages contains forty-four illustrations, mostly of specimens in the collection. It forms an interesting sketch of Fijian ethnography, written with that carefulness of detail which students have learnt to expect from Mr. Ling Roth. As coloured designs on bark cloth are found in some parts of New Guinea where direct Polynesian influence is entirely out of question, there seems no reason to believe, as Mr. Ling Roth suspects, that Fijian *masi* or *tapa* is a "Polynesian institution introduced among this Melanesian people." The same argument applies, though perhaps not so conclusively, to tatuing.

WHERE the Thompson and Fraser rivers meet at Lytton in Southern British Columbia has always been an important site of the Indians, as the ancient burial grounds and village sites testify. The late Dr. G. M. Dawson first described the remains in 1891, but recently the Jesup North Pacific Expedition made a series of explorations in this vicinity, of which an abstract has been described by Harlan J. Smith in the *Memoirs* of the American Museum of Natural History, vol. ii. part iii. (*Monumental Records*). The prehistoric culture resembles that of the present inhabitants of the interior of British Columbia. The mode of life of the prehistoric tribes, their utensils and even their customs must have been practically the same as those of recent Indians. There are, however, a few slight differences; the ancient type of pipe resembles the prehistoric pipe of Oregon and California, while the recent pipe is practically of the same type as that found on the plains. The potter's art was then, as now, unknown. On the whole the prehistoric culture of the interior of British Columbia shows greater affinity to that of the western plateaus than to that of the North Pacific coast.

MR. C. D. CHILD, writing in the *Physical Review* for February, describes some experiments made with the new method for determining the velocity of ions, recently suggested by Prof. J. J. Thomson. The method in question "is to produce the ions in one region and measure the electrical intensity at two points where there is no production of ions, but to which ions of one sign only can penetrate under the action of the electric field." The author shows by an application of Prof. Thomson's method that the velocity of the positive ions drawn from a Bunsen burner is approximately 2·2 cm. per sec. for potential gradient of 1 volt per cm., and that for negative ions 2·6 cm. Further, in the case of an unlimited supply of ions, if the discharge takes place between two regular surfaces, the velocity may be determined by simply measuring the current per unit area and the difference of potential between these surfaces, and if the surfaces are not at all regular the relative velocities of the positive and negative ions may be determined by comparing the positive and negative currents.

IN a paper on stationary motions, published in the *Atti dei Lincei*, x. 5, Signor T. Levi-Civita has endeavoured to furnish a more precise definition than commonly exists of the conception of stationary motion. Routh's definition, taken in its purely formal aspect, leads to the conclusion that by a proper choice of variables any motion may be regarded as stationary. On the other hand, experience teaches us that certain motions possess peculiar characters of simplicity and regularity which distinguish them clearly from other motions, and, moreover, Routh's examples show that in certain cases his definition actually does distinguish stationary motions (in the physical sense) from non-stationary motions. The author considers that the distinguishing characteristic in such cases is that the integrals or invariable relations which determine stationary solutions are always *uniform* in the sense considered by Poincaré. According to Routh, a stationary motion Σ is characterised by the property that if the conditions are equally modified at any two instants, t', t'', the disturbed motions Σ', Σ'' present relations such that under a certain condition they may be regarded as equivalent. Now Signor Levi-Civita considers that an analytical condition which is not uniform has no physical interest, and he is of opinion that Routh's definition of stationarity should be completed by adding the proviso that the relations between two disturbed motions, Σ', Σ'', should be uniform. As an example,

it follows that the problem of n bodies does not admit of any forms of motion absolutely stationary beyond the particular solutions of Laplace, in which the bodies rotate uniformly, maintaining an invariable (plane or rectilinear) configuration. On the other hand, the chief problems of ordinary dynamics conform to the property in question.

We learn from the April number of the *Entomologists' Monthly Magazine* that the late Mr. Lennon's collection of British Coleoptera has found a permanent home in the Edinburgh Museum of Science and Art. Its richness may be gathered from the circumstance that the number of species from the Solway district alone is estimated at more than twelve hundred.

In addition to several papers dealing with abnormalities in human anatomy and others on ethnology, the *Proceedings* of the Anatomical and Anthropological Society of the University of Aberdeen for 1899-1900 contains an abbreviated report of a lecture delivered before the University by Dr. A. Keith, on the relations of man to the higher Primates. The lecturer expressed his opinion that the gorilla and chimpanzee are co-descendants of an early Miocene anthropoid, for which the name Protroglodytes was suggested. It was estimated that more than five million years have elapsed since the separation of the human stock as a distinct form.

The osteology of the woodpeckers forms the subject of a paper by Dr. R. W. Shufeldt in the October-December issue of the *Proceedings* of the American Philosophical Society. As the result of his investigations, the author concludes that these birds are more nearly related to the Passeres than to any other group, and that both are probably divergent branches of a single ancestral stock. In a second communication to the same journal, Dr. Shufeldt treats of the skeleton of the owls, and arrives at the conclusion that there is no marked affinity between that group and the diurnal birds of prey. Rather, he thinks, there is a relationship, although a remote one, between the owls and the nightjars, the South American oil-bird (Steatornis) and the Australasian Podargus being the members of the latter group in which the evidence of strigine affinities is most conspicuous.

The journal last quoted also contains an interesting communication by Mr. R. H. Mathews, dealing with the origin and customs of the Australian aborigines. It is argued that the Australians reached their present home by way of the Malay Islands, but that the immigration has taken place at more than one epoch, the later immigrants being of a higher grade than their predecessors. The earlier immigrants are considered to have been of the Melanesian type, and their unmodified descendants were the now extinct Tasmanians. The later invaders, on the other hand, never reached Tasmania, which had, at the time of their arrival, become insulated. "There is nothing unreasonable," adds the author, "in the assumption that these invaders and the native tribes of the southern portion of India are the descendants of a common stock—the Australians, owing to their long isolation, having retained the primitive character of their Neanderthaloid ancestors, while the later Indian tribes have attained a higher grade of evolution." Possibly this may be the real solution of an extremely puzzling ethnological problem.

The *Century Magazine* for April contains an excellent and fully illustrated popular account, by Dr. L. O. Howard, the chief entomologist of the U.S. Department of Agriculture, of the recent investigations connecting the propagation of malaria with mosquitoes of the genus Anopheles. The author first of all dwells upon the great prevalence of malaria in certain parts of the world. Although in temperate regions the mortality from this disease is not high, in one year in the United States the deaths due to malarial fever were 3976 per 100,000, and in a later year 2673 per 100,000. In Italy the average death-rate from this cause is 15,000 annually, while in India five million deaths were ascribed to "fever" in 1892, and in Italy two million persons suffer annually in one way or another from malaria. The malaria-producing species are then described, after which comes a description, with illustrations, of the development of the malaria-parasite in the red blood corpuscles and in the body of the Anopheles mosquitoes. The article concludes with a brief reference to the evidence now being collected to connect yellow fever with a mosquito. Instead of belonging to Anopheles, the suspected insect pertains to the genus Culex (or perhaps represents a genus by itself); and it is considered probable, if the suspected connection between this insect and yellow fever be verified, that the fever germ will prove to be a protozoon, that is to say, an animal, and not a bacterion or vegetable organism. The experiments in question were made during last summer and winter by the U.S. Army surgeons in the hospitals at Cuba; and they tend to show with a reasonable degree of certainty that mosquitoes which have bitten patients suffering from yellow fever may, and do, convey the disease by biting healthy persons.

We have received the annual report of the Indian Museum, Calcutta, for the year ending March 31, 1900, and are pleased to learn that considerable progress has recently been made in the development of that institution. Owing to the removal of the offices of the Geological Survey to another building, four additional galleries are available for exhibition, and the superintendent, Major Alcock, reports that three of these have been already opened to the public. They have respectively been filled with reptiles, fishes and insects, arranged with special regard to the requirements of the student of the Indian fauna. The transfer of these specimens has allowed a much-needed expansion of some of the other groups. A very large proportion of the work of the staff has, indeed, been devoted to the improvement and rearrangement of the exhibition series, which, as the superintendent remarks, is that portion of the museum whereby progress is gauged by the public, and where the influence of the museum is most exerted. It may interest museum officials in this country to learn that most of the fishes in the Indian Museum are now coloured in imitation of their natural tints and that a large proportion of the reptiles and amphibians are represented by coloured clay models. Almost the only thing that Major Alcock has to lament is the circumstance that the post of naturalist to the surveying ship was vacant during the greater part of the year, in consequence of which the museum's list of acquisitions fell much below the normal.

The second part of a bibliography, guide and index to bacteriological literature, belonging to vol. i. (Bacteria) of "The Scientific Roll" has been received. The magazine, which is conducted by Mr. Alexander Ramsay, contains lists of papers published from 1876 to 1892 (both inclusive), arranged in each year alphabetically according to authors' names.

A new edition (the third) of Mr. W. W. Rouse Ball's inspiring "Short account of the History of Mathematics" has been published by Messrs. Macmillan and Co., Ltd. The work originally appeared in 1888 and was described in detail in these columns (vol. xxxix. p. 265). The present edition has been revised but not materially altered.

Four parts of the first volume of *Proceedings* of the University of Durham Philosophical Society, containing papers brought before the Society in the years 1896-1900, have been received. As a record of the Society's contributions to knowledge during the first four years of its existence, the *Proceedings* are very creditable. Many of the papers contain the results of

research, and others deal with various aspects of science descriptively. Such a society is a centre of beneficial influence, for it encourages investigation, affords facilities for the communication of facts and ideas, and promotes the friendly intercourse which broadens the views and sympathies of workers in different fields.

INCREASING interest in physical chemistry is shown by the fact that Prof. Walker's "Introduction to Physical Chemistry" (Macmillan), which was published towards the end of 1899, is already in its second edition. The book, which contains a full discussion of the chief principles of modern physical chemistry and shows their application to ordinary laboratory chemistry, has already been noticed in these columns (vol. lxii. p. 76, May 1900). Among other new matter in the new edition are accounts of "Berthelot's method for determining exact molecular weights from the limiting densities of gases, Traube's volume researches, and the position of the recently-discovered atmospheric gases in the periodic system."

IN the current number of the *Berichte*, Messrs. Pictet and Rotschy give an account of the isolation of three new alkaloids from tobacco. Up to the present only a single organic base, nicotine, has been found in tobacco. In most plants producing alkaloids several bases usually occur together, and as it appeared unlikely that the tobacco plant should prove exceptional in this respect, a large quantity of tobacco extract was worked up, with the result that three new bases were discovered, to which the names nicoteïn, nicotellin and nicotimin are given. Of these, the last is associated with the crude nicotine, with which it is isomeric, differing, however, in being a secondary base and forming a nitrosamine by means of which it can be separated from the nicotine, in spite of the fact that it is present in very small amount in the crude base. The nicoteïn contains two atoms and the nicotellin four atoms of hydrogen less than nicotine.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. H. Plange; a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mrs. Yorke; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. W. K. Edwards; a Common Otter (*Lutra vulgaris*), British, presented by Mr. W. Radcliffe Saunders; a Maximilian's Aracari (*Pteroglossus wiedi*) from Brazil, presented by Mrs. J. Rose; a Common Viper (*Vipera berus*), British, presented by Mr. G. Leighton; two Spanish Cattle (*Bos taurus*) from Spain, a Black-faced Kangaroo (*Macropus melanops*) from Tasmania, a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*) from South Australia, a Grevy's Zebra (*Equus grevyi*) from Southern Abyssinia, three Zebus (*Bos indicus*) from India, two Nubian Goats (*Capra hircus*) from Nubia, five four-horned Sheep (*Ovis aries*) from St. Kilda, two Somali Ostriches (*Struthio molybdophanes*) from Somaliland, deposited; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. F. Layer.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF NOVA PERSEI.—Prof. Vogel, in a recent communication (*Sitzber.* d. k. Akad. der Wiss. zu Berlin, March 21, xvi.), gives the results of a discussion of the Potsdam observations of Nova Persei. Prof. Vogel considers that the spectrum can only be explained on the hypothesis of Wilsing. The immense perturbations in the star give rise to great differences of pressure in the layers of the materials composing the Nova, and these differences account not only for the presence of the bright and dark lines, but their great breadth. Prof. Vogel does not think that there is any reason to assume that the apparent great displacement of the dark lines is the consequence of a large motion deduced on the principle of Doppler. This displacement he accounts for on the supposition of the overlapping of the broad dark band over the bright band, the great pressure of the substance giving the bright band being more strongly developed on the red side, thus allowing the dark band to appear more prominent on the violet side.

STONEHENGE AND OTHER STONE CIRCLES.

TWO interesting papers on stone circles, by Mr. A. L. Lewis, have recently been published by the Anthropological Institute. One dealing more particularly with the stone circles of Scotland occurs in the *Journal* of the Institute (vol. xxx. New Series, vol. iii. 1900), and the other, on the damage recently sustained by Stonehenge, appears in *Man*—the monthly record of anthropological science published under the direction of the Institute. We reprint the latter paper, with the two illustrations accompanying it, and are glad to acknowledge the courtesy of the Institute in permitting us to do so. And here it will not be out of place to remark that both the *Journal* and *Man* are full of papers and notes of interest to every one devoted to the study of the human race in its many aspects. When one considers how little encouragement is given to the science of anthropology in this country, it is really astonishing to see the large amount of excellent material published under the auspices of the Anthropological Institute. The U.S. Bureau of Ethnology have funds to publish magnificent volumes showing the results of ethnological investigations carried on by its officers, but here there is no similar department for the preparation and distribution of such contributions to science, and anything that is done represents the result of private efforts for the advancement of natural knowledge. Even if no assistance is given to systematic anthropological inquiries in our colonies and dependencies, every facility ought to be provided for the publication of facts obtained by observers interested in the characteristics and customs of the races of men.

Mr. Lewis describes, in the *Journal* already mentioned, the observations made by him of stone circles in various parts of Scotland. The condition of some of these monuments of antiquity is deplorable, many of the stones having been shifted and used for all kinds of purposes. At Clava, for instance, we notice that one stone has been shifted to be parallel with a road running across the circle, and another has been placed to form the end of a stone wall. From an examination of a large number of stone circles in Scotland, Mr. Lewis concludes that they may be divided into different types each of which has its centre in a different locality. The types are (1) the Western Scottish type, consisting of a rather irregular single ring or sometimes of two concentric rings. (2) The Inverness type, consisting of a more regular ring of better-shaped stones, surrounding a tumulus with a retaining wall, containing a built-up chamber and passage leading to it, or a kist without a passage. (3) The Aberdeen type, consisting of a similar ring with the addition of a so-called "altar-stone" and usually having traces of a tumulus and kist in the middle. There is reason to believe that most of the circles of these three types were used for burial, if, indeed, that were not their chief purpose, but as there is evidence that all have not been so used, it cannot have been their only purpose. In addition to these three types of circles, there are what Mr. Lewis calls sun and star circles, with their alignments of stones, and apparently proportioned measurements. The stone circles of England appear to refer to the sun and stars more frequently than those of Scotland, where, however, more similar circles may yet be found. The Stonehenge group of stones seems almost to form a class by itself, and Mr. Lewis's description of it, reprinted below from *Man*, describes the present condition of this unique monument.

"The end of the nineteenth century has been signalised by—amongst other things—the fall of a part of Stonehenge, a misfortune which may not be without its compensating advantage if it should be the cause of the necessary measures being taken to preserve what is left of this unique monument in an intelligible condition.

"Stonehenge, it will be remembered, consists of a number of comparatively small stones standing in the form of a horse-shoe with the open end to the north-east, outside which were five "trilithons," or sets of two upright stones, each supporting a huge cross-piece; these were the largest stones of all, and only two sets of them remain complete, the last great change at

Stonehenge having been the fall of one of them in January 1797. Outside these was a circle of small stones, and outside these again a circle of larger upright stones, joined at the top by cross stones; both these circles are so defective, especially towards the south-west, that it has been doubted whether they ever were complete. It is one of the uprights of this outer circle (marked

Fig. 1.—Plan of Stonehenge. A, Stone now fallen. BB, Stones which fell in 1797.
(*Reproduced from "Man."*)

A on the plan—No. 22 on Petrie's plan) that has now fallen inward, carrying with it the capstone which connected it with the adjoining stone, and which has been broken in two by striking in its fall the remains of the trilithon which fell in 1797.

"It is, perhaps, fortunate that these stones have fallen instead of the remaining stone of the central trilithon, the downfall of which has long been expected on account of its leaning position, an occurrence which, if not prevented, will cause much more damage than has been caused for centuries, and the practical question for archæologists is what is to be done to prevent it? Of course, no one advocates "restoration" in the sense of adding new stones to supply the places of those which have disappeared; but, inasmuch as the exact original position of almost every existing stone is perfectly obvious, and inasmuch as exact surveys have been made and published both by Sir Henry James on behalf of the Ordnance Survey,[1] and by Prof. Flinders Petrie,[2] there should be no objection to setting the leaning stones upright, so as to prevent them falling and breaking themselves and others, and to setting up those that are quite fallen, except those that are too much broken to be capable of being joined together. Such fragments should be left where they are, as also should any the precise original position of which cannot be ascertained. Next comes the question of keeping the stones in their position when they have been restored to it; and the best way to do this would be to dig out the whole interior down to the solid chalk, underpinning the stones while the work was going on, and to fill it up with concrete. In the digging out it might be expected that some relics would be found which might throw light on the date if not on the purpose of the monument; but the objection will no doubt be made that future generations might think that the concrete was part of the original work. This would be less likely to happen if the concrete were covered for its better preservation with half an inch of the best asphalte, such as is used in paving the London streets, under which boxes with documents might be buried for the benefit of any future excavators.

"If it were possible to keep things as they are, it might be preferable from an artistic point of view to do so, but it is not possible. If something be not done to prevent them further falls will happen, and where will be the poetry in a shapeless heap of broken stones?

"It must, however, be remembered that Stonehenge, though an object of national concern, is private property."

A plan of Stonehenge is given in the *Times* of Tuesday, April 9, with a description of the condition of the monument and the natural and other causes which threaten to do mischief to it. To protect the monument, Sir Edmund Antrobus is prepared to erect around it, at his own cost, a wire fence 1500 yards in total length.

This course is recommended by the Society of Antiquaries, the Wiltshire Archæological Society, and the Society for the Protection of Ancient Monuments, and the suggestion has the approval of the county council, the district council, and the parish council of Amesbury. The societies further recommend

Fig. 2.—View of Stonehenge from the west. A, Stone now fallen. BB, Stones which fell in 1797.
(*Reproduced from "Man."*)

1 "Plans and Photographs of Stonehenge and of Turnsuchan in the Island of Lewis." 4to. Ordnance Survey: Southampton, 1867.

2 "Stonehenge: Plans, Descriptions and Theories." 4to. London: Stanford, 1880.

the diversion of a grass driving road which now cuts across the earthwork, without prejudice to any legal question.

To prevent other stones from falling it is suggested by the societies mentioned that the trilithon which has slewed round and also a leaning-stone be first examined with a view to maintaining them in safety. It is understood that no excavation beyond what is absolutely necessary will be allowed. This examination will show what can be done and ought to be done with all the standing Sarsens. It is advised that the monolith and lintel, which fell three months ago, be replaced, the companion Sarsen being made safe against the effects of the fall. Further, the societies recommend the erection of the great trilithon which fell in 1797, the exact place of which is known. All the rest they would leave as it is, though in some cases the place of fallen stones is known with fair certainty. The questions of how best to fix more firmly in the ground the stones now standing, and how best to re-erect the two trilithons which have fallen in the last 104 years, is left to engineering experts.

A STUDENT'S DRUM RECORDER.[1]

THIS admirable instrument consists of five parts easily detachable, viz. (i.) an adjustable tripod, which carries on one foot (ii.) a steel bracket for the attachment of the appurtenances incident to an observation; and (iii.) a central adjustable rod so fashioned as to receive (iv.) the drum, the heads of which are widely perforated for purposes of manipulation; and (v.) a clockwork driver, which is keyed at two points for insertion into the head of the rod. The special novelty of the instrument lies in the driver, which is so constructed that when at work it and the drum are together rotated. The driver is, moreover, set in a metal framework supported upon three feet, upon which it rests when not in use, adequately protected. Its working parts are all exposed, and there are no accessories. The arbor of the spring-wheel above, and of the main driving-wheel below, are each so keyed as to fit into the head of the rod or axle, the former being intended for slow motion, the latter for quick. For one winding the drum will run at its most rapid rate for 12–13 minutes, at its slowest for 16–17, allowance being made for adjustment of the wings of the "fly," which as a whole can be itself easily removed to ensure the maximum obtainable speed. The instrument is a triumph of ingenuity and good workmanship, and we have nought but praise to accord it. To produce at little more than one-fourth the price of the conventional drum-recorder a substitute in efficiency its equal, is to deserve well of the scientific public. This drum supplies a want long felt by teachers, and is bound to become popular. We heartily wish it the success it deserves.

FIG. 1.—A Drum Recorder dismounted to show its parts.

[1] By W. E. Pye and Co., "Granta Works," Mill Lane, Cambridge. Price 70s.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. HERBERT F. ROBERTS, instructor in botany in Washington University, at St. Louis, Missouri, U.S.A., has been elected to the chair of botany in the Kansas State Agricultural College.

FOR the last two or three decades the engineering profession of Austria and Hungary spared no efforts to raise the technical institutions throughout those countries to the standard of the universities and to obtain for the former some of the more important academic privileges and powers which the latter have enjoyed since their establishment. The first aim of the leading members of the said profession was that the technical institutions should be authorised by the Government to grant degrees which, from an academic point of view, should be regarded as equal to those granted by the universities. We now notice, therefore, with satisfaction that their endeavours have been finally crowned with the desired success, and that the Minister of Public Instruction in Austria held, on April the 4th, a meeting which was attended by representatives of almost every technical institution in that country, and on this occasion announced the Government's intention of introducing a special statute by means of which the technical high schools should be empowered to confer the degree of Doctor of "Rerum Technicarum" upon students whose scientific attainments entitle them to that distinction. A special examining body will be appointed for that purpose, and some of the examiners, it is urged, should be at the same time members of the teaching staff in connection with some of the universities; the examinations, again, will be conducted on the same lines as those prescribed by the philosophical faculty of a university for the bestowal of the degree of Ph.D. The acquirement of that degree, however, will not—at least for the present—be made compulsory for all students of the technical academies; those, on the other hand, who attain it will, of course, be given special precedence in the case of Government appointments, which are usually accessible to all graduates of the recognised technical institutions by open competition.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, March.—Prof. T. F. Holgate reports the December meeting of the Chicago section of the Society (December 27 and 28, 1900), and gives abstracts of several of the twenty-two papers which were read. In addition there is printed a paper by Prof. Hathaway on pure mathematics for engineering students, which was followed by an interesting discussion. The subject was treated under the heads (1) its utility; (2) methods of instruction; (3) the course; and (4) the instructor.—A paper read by Prof. Newson, at the February meeting, on indirect circular transformations and mixed groups, is supplementary to a paper entitled "Continuous Groups of Circular Transformations" (which appeared in the *Bulletin* for December, 1897), and deals with indirect circular transformations and the mixed groups obtained by combining these with the direct transformations. Prof. E. W. Brown reviews, at some length, the scientific papers of J. Couch Adams and the lectures on the Lunar theory, (vol. ii. Parts 1 and 2), edited by Profs. R. A. Sampson and W. G. Adams. Then follows, in English, the notice on M. Hermite, by M. C. Jordan, an address delivered at the meeting of the Paris Academy of Sciences, January 21, 1901.—The notes, as usual, cover a wide ground, and there is the usual portion appropriated to new publications.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 14.—"On the Ionisation of Atmospheric Air." By C. T. R. Wilson, F.R.S., Fellow of Sidney Sussex College, Cambridge.

In a preliminary note (*Camb. Phil. Soc. Proc.*, November 26, 1900) it was stated that a body, charged with electricity and suspended within a vessel containing dust-free air, loses its charge by leakage through the air. The same conclusion was arrived at by Geitel in a paper published a few days previously (*Physikalische Zeitschrift*, 2 Jahrgang, No. 8, pp. 116–119). The leakage

was in each case attributed to the continuous production of ions throughout the volume of the air. In the present paper a description is given of the apparatus used in Mr. Wilson's experiments, and of further results obtained with it. The air, in most of the experiments, was contained in a glass bulb, coated internally with a layer of silver sufficiently thin to enable the position of a gold leaf within the vessel to be read by means of a microscope. The gold leaf was attached to a narrow brass strip, fixed by means of a sulphur bead to a brass rod passing through the neck of the bulb. The brass strip and gold leaf formed the whole of the system of which the fall of potential was observed; the capacity was thus very small. To avoid all danger of being misled by leakage through the insulating support, the rod, to which the leaking system was attached by the sulphur bead, was kept at constant potential by means of a condenser of zinc plates embedded in sulphur. By a momentary contact, brought about with the aid of a magnet, the initial potential of the leaking system was made equal to that of the supporting rod. The rate of leakage in air at atmospheric pressure corresponds to the production of about twenty ions of either sign in each c.c. per second; the ionisation is approximately proportional to the pressure. Experiments made with a portable apparatus showed that the ionisation in a closed vessel is the same when the experiment is performed in an underground tunnel as above ground. It appears, therefore, not to be due to the action of ionising radiation which has traversed our atmosphere.

"The Chemistry of Nerve-degeneration." By Dr. F. W. Mott, F.R.S., and Dr. W. D. Halliburton, F.R.S.

Linnean Society, March 21.—Mr. F. D. Godman, F.R.S., vice-president, in the chair.—Mr. J. E. Harting exhibited and made remarks on some photographs of female roedeer (*Capreolus caprea*) bearing antlers, one of which had been shot at Neudau, in East Styria, in December last.—Mr. H. J. Elwes, F.R.S., considered the case so remarkable and unusual as to suggest the probability of some mistake having been made in determining the sex. Mr. Harting, in reply, stated that this was by no means unique. In Germany, where roedeer are much more plentiful than in this country, several does with antlers had been recorded. Dr. Altum, in his *Forstzoologie* (Bd. i. p. 211), states that many such cases were known to him. One instance noted in the Black Forest at Kippenheim is mentioned in *The Zoologist*, 1866, p. 435. In that case the horns were "in the velvet," but perfectly hard; one was about 6 in. long with a single short tine, the other about 3 in. without any tine. A female roe with budding horns was shot in October 1875 by Mr. Duncan Davidson, of Inchmarlo, Banchory, Aberdeenshire. The skull of another in the museum of the Royal College of Surgeons, forwarded from Petworth Park, Sussex, by Lord Egremont, is figured in the *Proceedings of the Zoological Society*, 1879, p. 297. Mr. Harting also pointed out that such cases were not confined to the genus Capreolus, but had been noted rarely in *Cervus elaphus*, and once in the case of the American white-tailed deer *Cariacus virginianus* (shot in East Kootenay, British Columbia), a photograph of which he exhibited.—Mr. P. Chalmers Mitchell read a paper entitled "The Anatomy and Morphology of the Intestinal Tract in Birds; with Remarks on the Nomenclature and Valuation of Zoological Characters." He described the various conformations of the intestinal tract in birds, his material consisting of many hundreds of specimens belonging to all the living Ratitæ as well as all the orders and suborders and nearly all the families of Carinatæ. He discussed the morphology of the tract, distinguishing, in their adult anatomy and in their relation to the embryonic metamerism, the duodenum, Meckel's tract, and the rectum. He described the nature and distribution of the changes in these organs and in Meckel's diverticulum, and the colic cæca, and gave an account of a remarkable and hitherto undescribed series of nervous structures belonging to the autonomic nervous system apparently peculiar to birds. In discussing the relation of the series of facts described to the systems of avian classification, he insisted on the primary necessity of valuing characters as archicentric or apocentric, primitive or specialised. A common possession of a character in either the archicentric or apocentric condition was no indication of systematic affinity. Amongst apocentric characters he distinguished between *multi-radial apocentricities* (many of which were plastic effects and afforded no guide to affinity) and *uniradial apocentricities* which had arisen by a limitation and definition of variability in a particular branch of the family tree.

Geological Society, March 20.—J. J. H. Teall, V.P.R.S., president, in the chair. Prof. Friedrich Johann Becke, of Vienna, was proposed as a foreign correspondent of the Society.—Mr. H. B. Woodward called attention to a polished slab of landscape marble, or cotham stone, from the Rhætic Beds near Bristol, which had been lent for exhibition by Mr. Frederick James, curator of Maidstone Museum. The specimen showed that after the arborescent markings had been produced in the soft mud, some irregular and partial solidification took place in the upper layers of the deposit; and then during contraction a kind of subsidence occurred of the upper and harder portions into the lower and softer materials. This subsidence was accompanied by a breaking-up of the harder portions, suggesting a comparison (in miniature) with "broken beds" and even crush-conglomerates. The specimen was of considerable interest, as illustrating the mechanical changes produced during solidification. The following communications were read:—On a remarkable volcanic vent of Tertiary age in the Island of Arran, enclosing Mesozoic fossiliferous rocks (communicated by permission of the Director-General of H.M. Geological Survey). Part i. On the geological structure, by Benjamin Neeve Peach and William Gunn. The rocks which form the subject of this paper cover an area of about seven or eight square miles, and culminate in Ard Bheinn A'Chruach and Beinn Bhreac. They are in contact with formations ranging from the Lower Old Red Sandstone to the Trias, and are later in date even than the important faults of the area. They are made up partly of fragmental volcanic materials, and partly of various intrusive masses, confined within an almost unbroken ring of intrusive rocks. In addition to igneous fragments the clastic volcanic rocks contain fragments derived from the surrounding formations; and also masses of shale, marl, limestone and sandstone belonging to formations not now found *in situ* in the island. One of these is several acres in extent, contains fossils, and is in part of Rhætic age; a second is a fragment of Lias; and a third is of limestone and chert resembling the Antrim Cretaceous rocks, and yielding fossils. The absence of Oolitic and older Cretaceous seems to indicate a resemblance between a former succession in Arran and that now seen in Antrim.—Part ii. "Palæontological Notes, by E. T. Newton, F.R.S. The masses of Rhætic strata yield *Avicula contorto*, *Pecten valoniensis*, *Schizodus* (*Axinus*) *cloacinus*, etc.; those of Lower Lias *Gryphæa arcuata*, *Ammonites angulatus*, and new species of *Nuculana* and *Tancredia*, which are figured and described. Thin slices of the Cretaceous limestones prove to be very like those of the Antrim chalk, and the rocks yield determinable foraminifera, *Inocerami*, sponges, and echinoderms.—On the character of the Upper Coal Measures of North Staffordshire, Denbighshire, South Staffordshire and Nottinghamshire; and their relation to the productive series, by Walcot Gibson (communicated by permission of the Director of H.M. Geological Survey). The Upper Coal Measures of North Staffordshire are capable of a fourfold subdivision, the groups representing a definite sequence of red and grey strata.

MANCHESTER.

Literary and Philosophical Society, March 19.—Charles Bailey, vice-president, in the chair.—Mr. E. F. Morris exhibited two drawings of recent excavations in the Roman Forum. The one represented a rostrum, stated to be that from which Antony delivered his famous speech. It is built of tufa and concrete, and consists of five little vaulted rooms, as seen in the well-known medal of Palikanus. The other was a sketch of a little ædicula in brick work, the front decorated with two marble columns supporting an architrave on which is carved the name of the deity (Juturna) to which it was consecrated. In front of it is a circular well with an elegant marble head, ornamented with a carved cornice bearing an inscription stating that the well was consecrated to Juturna by Marcus Barbatius Pollio. Before the well is a marble altar with a sculptured front, on which are the figures of Mars and of a female deity—Juno or Venus. Signor Boni has also brought to light the celebrated fountain of Juturna, which is enclosed by a spacious rectangular construction in tufa-work of the Republican epoch. The water now gushes out fresh and clear, in abundance. The sculptures in the room enclosing the spring were also described.—Mr. Thomas Thorp showed photographs of the spectrum of the new star in Perseus, showing the bright lines very clearly. Mr. Thorp also described a variation in the ordinary arrangement of a star spectroscope, in which the eye-piece of the telescope used is replaced by a

doublet, one of the elements of which is a long focus lens which can be tilted and by that means made to yield a band of light in place of the line, an effect ordinarily secured by means of a cylindrical lens, as in Maclean's method.—The macro-lepidoptera of Sherwood Forest, by J. R. Hardy. The paper contained a list of 269 species collected in the course of the past twenty-two years, mostly in the district between Worksop, Edwinstowe and Chekerhouse. All the species, some of which are peculiar to the district, have been deposited in the Manchester Museum.

PARIS.

Academy of Sciences, April 1.—M. Fouqué in the chair.—A general proposition in the calculus of probabilities, by M. A. Liapounoff.—On the deformation of the general paraboloid, by M. Servant.—On the sum of the angles of a polygon with multiple connection, by M. M. d'Ocagne.—Studies in psycho-acoustics, by M. F. Larroque.—On the electro-capillary properties of some organic compounds in aqueous solution, by M. Gouy. If H is the maximum height of the column of the capillary electrometer with a given solution of a standard electrolyte, and H' the maximum height after the addition of an organic substance, then $1000\ (H-H')/H$ is a constant which varies with a constitution of the body and which varies with dilution in a characteristic manner. Preliminary measurements are given for a number of organic substances.—On some osmyl-oxalates, by M. L. Wintrebert. The osmyloxalates form a well characterised series of salts, details being given of the mode of preparation and properties of the salts of sodium, ammonium, silver, barium, strontium and calcium.—On the reducing properties of magnesium and aluminium, by M. A. Duboin.—On cinchonine, by MM. E. Jungfleisch and E. Léger. Ordinary commercial cinchonine always contains a variable quantity of hydrocinchonine, the separation of the latter being a somewhat tedious process. The physical constants of the purified cinchonine salts were determined and found to differ considerably from the accepted figures.—On some iodo-derivatives of phenol, by M. P. Brenans.—The action of the esters of dibasic acids upon the organometallic compounds, by M. Amand Valeur. The reaction of magnesium methyl iodide with the esters of oxalic, malonic and succinic acids was found to correspond with the action of the same reagent upon the esters of monobasic acids, except that with ethyl malonate an additional molecule of water is split off with the formation of an unsaturated alcohol.—On the organometallic compounds of magnesium, by MM. Tissier and Grignard. The principal product of the action of magnesium upon an alkyl iodide or bromide in ethereal solution is a compound of the type $C_nH_{2n+1}-Mg-I$, and this, on treatment with water, gives the hydrocarbon C_nH_{2n+2}. In the higher members of the series a secondary reaction takes place in which the hydrocarbon $C_nH_{2n+1}-C_nH_{2n+1}$ is formed. Thus secondary hexyl iodide gives hexane and dihexane.—Some new reactions of the organomagnesium compounds, by M. Ch. Moureu. Magnesium ethyl iodide reacts easily with amyl nitrite, giving diethyl-hydroxylamine. Nitroethane gives the same product, the reaction appearing to be a general one.—On the organomagnesium derivatives, by M. E. E. Blaise.—On a new synthesis of aniline, by M. George F. Jaubert. Benzene and hydroxylamine hydrochloride, heated with aluminium chloride, give traces of aniline.—On the mechanism of lipolytic reactions, by M. M. Hanriot.—On the internal organisation of *Pleurotomaria Beyrichii*, by MM. E. L. Bouvier and H. Fischer. Studies of the digestive tube and nervous system of this animal.—The sexual variation in the males of certain Coleoptera belonging to the family of the Bostrychides, by M. P. Lesne.—On the mode of production of eggs in *Trochus*, by M. A. Robert. The eggs of *Trochus conuloides* are produced in a long cylindrical string exactly resembling those of *Tr. granulatus*.—On the comparative value of saline and sugar solutions in experimental teratogenesis, by M. E. Bataillon.—On the origin of the paranuclei in the cells of the digestive gland of the crayfish, by M. P. Vigier.—Influence of the climatological conditions upon the growth of the shoots of the vine, by M. F. Kövessi.—The comparative study of the zoospore and the spermatozoid, by M. A. Dangeard.—New cytological researches on the Hymenomycetes, by M. René Maire.—On a conidian form of the fungus of black rot, by M. G. Delacroix.—The position and approximate velocity of a meteor, by M. Jean Mascart. A meteor which was seen in the neighbourhood of Angoulême on September 24, 1900, had a velocity of over 4 kilometres per second, and was entirely consumed at a height of about 40 kilometres.

NEW SOUTH WALES.

Royal Society, December 5, 1900.—Prof. Liversidge, F.R.S., president, in the chair.—Sir William Crookes, F.R.S., and Sir W. T. Thiselton-Dyer, K.C.M.G., F.R.S., were elected honorary members of the Society.—The following papers were read:—Intercolonial water rights as affected by federation, by H. G. McKinney.—The organisation, language, and initiation ceremonies of the aborigines of the south-east coast of New South Wales, by R. H. Mathews, and Miss M. M. Everitt.—This article described the laws of marriage, descent and relationship in force among the native tribes occupying the south-east coast of New South Wales from the Hawkesbury River to Cape Howe, on the Victorian frontier, and extending inland till met on the west by the Wiradjuri organisation. A grammar of the language of the Gundungurra, one of the principal tribes in the region dealt with, was also supplied, in which the structure of the native tongue was fully investigated and explained. The paper concluded with a short account of the Kudsha, or Narramang, a ceremony of initiation practised within the same geographical limits, by means of which the young men are admitted to the status and responsibilities of tribesmen.—Tables to facilitate the location of the cubic parabola, by C. J. Merfield. In some brief remarks the author gives an outline of the general application of the cubic parabola, when used as a transition to connect the straights and circular curves of railway lines. The paper forms a contribution to the engineering profession, and will be found useful to those engaged in the location of railway lines. A valuable table is appended, from which the constants of the curve for any case may be found. A complete numerical example illustrates the method of using the table.—Boogaldi meteorite, by Prof. Liversidge, F.R.S. This meteorite was exhibited by Mr. R. T. Baker at the June meeting of the Society, when he stated that it was found early in January 1900 at a place two miles from Boogaldi, a post town fifteen miles north-west of Coonanbarabran. Mr. Baker afterwards forwarded it to Prof. Liversidge for investigation and analysis. The meteorite is a metallic one or a siderite, and is somewhat pear-shaped; it is a little over five inches long by about three inches broad at the widest part, and it weighed before cutting 2057·5 grammes. Its sp. gr. at 14° C. was found to be 7·85. It was covered, as usual, with a closely adherent skin of fused oxides, except in one place where it had been detached, the exposed metal had a bright lustrous appearance like nickel iron. At the thick end of the meteorite the fused oxides forming the skin have been thrown into well-defined concentric waves or rings with transverse furrows in the direction of the thinner end of the meteorite—the waves and furrows gradually fade away in this direction. These waves and furrows are believed to show that the meteorite travelled through the earth's atmosphere with the thick end in front, the waves of fused oxide being thrown up by the resistance of the air, just as waves are formed in sand by the wind. That the meteorite did travel with the thick end first is confirmed by the fact that at the thin end there are longitudinal ridges and furrows in the fused skin which clearly show where the excess of fused oxide was dragged off; the luminous streak usually seen behind a meteorite is, if not wholly, certainly in part, due to the fused incandescence left in its trail. Hence the waves and other markings in the skin not only show the direction in which the meteorite travelled but also its position, *i.e.* with the curved point of the thin end downwards as represented in the photograph; for the fused oxides forming the skin are thickest on the lower side.—On a new aromatic aldehyde occurring in eucalyptus oils, by Henry G. Smith. In this paper the author records the results of his investigation (so far as he has gone) on the aldehyde occurring in so many eucalyptus oils, which had for a long time been supposed to be cuminaldehyde. The aldehyde occurs in greatest amount in the oils obtained from members of the group of Eucalypts known in Australia as the "Boxes." The true boxes, *E. hemiphloia*, *E. albens* and *E. Woollsiana*, contain it in the largest quantity. The oil was obtained from *E. hemiphloia*, this tree growing plentifully at Belmore, in the neighbourhood of Sydney. 1000 c.c. of the crude oil were distilled, and the constituents distilling below 190° C. removed, the remainder of the oil was agitated with acid sodium sulphite

with which it readily formed a solid compound, the pure aldehyde was easily obtained from this by the usual methods. The specific gravity of the aldehyde at 15° C. was ·9477. The specific rotation was $[\alpha]_D - 49·17°$, this somewhat high lævorotation causes those oils containing it to be lævorotatory, although mostly devoid of phellandrene. It is this aldehyde that causes the oil of *E. cnerifolia* of South Australia to be lævorotatory. The pure aldehyde has an aromatic odour and is slightly yellowish in tint. It was soluble in the usual solvents. The author proposes the name aromadendral for this aldehyde, and aromadendric acid for the corresponding acid.

St. Louis.

Academy of Science, March 18.—Prof. E. H. Keiser delivered an address showing the progress made in the science of chemistry during the nineteenth century.—Prof. F. E. Nipher exhibited pieces of pine board a foot square, showing the tracks of ball lightning discharges upon them like those formerly described by him in No. 6, vol. x. of the *Transactions* of the Academy. The discharges formerly described had been formed on a photographic film. The balls were very small, and wandered over the plate, leaving a track of metallic silver in their wake. In the present instance the balls were much larger, and they burned a deep channel in the wood. They are formed at the secondary spark gap of a coil. The terminals are pointed and are under control, so that the gap may be changed in length. To start the balls, the pointed terminals are put upon the wood surface, so near that the spark carbonises somewhat, after which the gap is made longer. These balls travel in either direction, when a direct current is used with a Wehnelt interrupter. This differs from the results reached on the photographic film with the Holtz machine. There the balls came from the kathode. Even when they originated at isolated points on the film, they travelled away from the kathode. In the present results, the balls have been caused to originate at isolated points, and two balls have started in opposite directions. Wood which gives little flame shows the phenomenon to best advantage, but the balls preserve their identity and travel slowly along even when completely surrounded by flames of the burning wood.

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part 4 for 1900, contains the following memoirs communicated to the Society:—

December 22, 1900.—W. Voigt: On the parameters of crystallo-physics, and on directed magnitudes of higher orders (tensors, rotors, torsors, &c.). J. Wellstein: Prime forms on Riemann surfaces.

February 9.—E. Ehlers: On Atlantic palolo-worms.

DIARY OF SOCIETIES.

THURSDAY, April 11.

Mathematical Society, at 5.30.—Summation of the Series $\Sigma_0^\infty \frac{\Gamma^3(a+n)}{\Gamma^3(1+n)}$: Dr. F. Morley.—On the Projective properties of Cubic and Quartics: A. B. Basset, F.R.S.

FRIDAY, April 12.

Malacological Society, at 8.—On the Dates of Publication of Kiener's "Species générales des Coquilles vivants," 1834-80: C. Davies Sherborn and B. B. Woodward.—New Species of Land-Shells from Central and South America: S. I. DaCosta.—Note on the Genus *Temesa*, with Descriptions of Two New Land-Shells from South America: E. R. Sykes.

Geologists' Association, at 8.—The Zonal Value of Red Strata in the Carboniferous Rocks of the Midlands: Walcot Gibson.

Royal Astronomical Society, at 5.—Note on some Engraved Charts of Pogson's Proposed Atlas of Variable Stars: Rev. J. G. Hagen.—Meteoric Showers from the Region α-β Persei and η Aurigæ: W. F. Denning.—Anomalous Occultations of Stars by the Moon: R. T. A. Innes.—A Method of Mechanically Compensating the Rotation of the Field of a Siderostat: H. C. Plummer.—Variations of R Horologii during 1900: A. W. Roberts.—Note on Meridian Observations of Nova Persei: A. Graham.—Further Observations of the New Star in Perseus: A. Stanley Williams.—(1) The Spectrum of Nova Persei; (2) The Spectrum of Nova Persei, Nova Persei as a Variable Star with a Variable Spectrum: Rev. W. Sidgreaves.——*Probable Paper*: The Magnitude of Nova Persei as deduced from Photographs taken with the Astrographic Equatorial, Royal Observatory, Grreenwich.

MONDAY, April 15.

Victoria Institute, at 4.30.—The Ice Age: Warren Upham.

TUESDAY, April 16.

Royal Institution, at 3.—Cellular Physiology: Dr. A. Macfadyen.

Zoological Society, at 8.30.—Revision of the Insects of the Order Rhynchota belonging to the Family *Coreidae* in the Hope Collection at Oxford: W. L. Distant.—On some Earthworms from Tropical Africa, and on the Spermatophores of *Polytoreutes* and *Stuehlmannia*: F. E. Beddard, F.R.S.—On the Identity and Distribution of the Mother-of-Pearl Oysters: a Revision of the Subgenus *Margaritifera*: Dr. H. Lyster Jameson.

Institution of Civil Engineers, at 8.—Modern Practice in the Manufacture and Distribution of Gas: Harry E. Jones.

WEDNESDAY, April 17.

Society of Arts, at 8.—The Synthesis of Indigo: Prof. Raphael Meldola, F.R.S.

Royal Meteorological Society, at 7.30.—Special Characteristics of the Weather of March, 1901: W. Marriott.—Vapour Tension in Relation to Wind: R. Strachan.

Royal Microscopical Society, at 8.—Demonstration on the Metamorphoses of *Æschna cyanea*, illustrated by Photographs from Life: Fred Enock.

Sanitary Institute, at 8.—Sewage Purification and Standards of Purity: Dr. H. R. Kenwood and Dr. W. Butler.

THURSDAY, April 18.

Royal Institution, at 3.—Naturalism in Italian Painting: Roger Fry.

Society of Arts (Indian Section), at 4.30.—Madras, the Southern Satrapy: J. D. Rees.

Röntgen Society, at 8.—Meeting for Discussion. Subject: X-Ray Therapeutics: To be opened by Miss M. M. Sharpe.

Chemical Society, at 8.—Researches on Moorland Waters. Part II. On the Origin of the Combined Chlorine: W. Ackroyd.—Robinin, Violaquercitrin, and Osyritrin: A. G. Perkin.—Preparation of Orthodimethoxybenzoin, and a New Method of preparing Salicylaldehydemethylether: J. C. Irvine.—(1) Action of Alkyl Haloids on Aldoximes and Ketoximes, Part II. (2) The Supposed Existence of Two Isomeric Triethyloxamines: Wyndham R. Dunstan and E. Goulding.—(1) Nitrocamphene, Aminocamphene, and Hydroxycamphene; (2) Action of Hydroxylamine on the Anhydrides of Bromonitrocamphane: M. O. Forster.—The Influence of Cane Sugar on the Conductivities of Potassium Chloride and Potassium Hydroxide, with Evidence of Salt Formation in the Latter Case: C. J. Martin and O. Masson.

Institution of Electrical Engineers, at 8.—Replies of Mr. H. Ravenshaw and Mr. S. F. Walker to the Discussion on their Papers read at the last Meeting.—Test-Room Methods of Alternate Current Measurements: A. Campbell.—Note on the Use of the Differential Galvanometer: C. W. S. Crawley.

FRIDAY, April 19.

Royal Institution, at 9.—The Existence of Bodies Smaller than Atoms: Prof. J. J. Thomson, F.R.S.

Institution of Civil Engineers, at 8.—The Theory of Cast-Iron Beams: E. V. Clark.

Institution of Mechanical Engineers, at 8.—Address by the President, W. H. Maw.

SATURDAY, April 20.

Royal Institution, at 3.—Climate: its Causes and Effects: J. Y. Buchanan, F.R.S.

CONTENTS.

THURSDAY, APRIL 18, 1901.

EGYPTIAN CHRONOLOGY.

A Self-verifying Chronological History of Ancient Egypt. A Book of Startling Discoveries. By Orlando P. Schmidt. Pp. 569. (Cincinnati: O. G. C. Shaw, 1900.)

THE portly volume before us professes to deal with the "chronological history" of Egypt, and to treat the subject in such a lucid manner that every part of it explains itself and "proves" itself. The author is candid, and advertises his work in the freest possible manner, and he appears to be thoroughly convinced of the supreme value of his labours. According to him, the field of Egyptian history was hastily explored, "usually at odd times"—whatever that may mean—but armed with his "key," which a "fortuitous discovery" had placed in his hands, he "entered a lost world, all recollection of which had died out, and there made a series of discoveries, and gathered together a great mass of new historical facts, the startling and far-reaching importance of which it would be almost impossible to estimate." He admits that he once held many of the opinions common to modern Egyptologists in general, but his "native common sense recoiled from" the errors and superstitions regarding the Egyptians which were current among so-called "scientists"; though of certain errors and superstitions he once found it impossible to free his mind, and apparently this is still the case. He wrote his book whilst "the researches were being made," and his "point of view was constantly changing," and his "horizon was constantly widening." Among Egyptologists, the author thinks "superficial skepticism" has taken the place of "scientific criticism," and this had led many of them "to belittle and misrepresent the civilisation of Egypt prior to the beginning of the Fourth Dynasty," and they tell us "flat footed" (whatever this word may mean here) "that the first three dynasties of Manetho were mythical." Mr. Schmidt thinks that the names of Noah, Shem, Ham and Japheth are Egyptian and not Hebrew words, and he says that "scientists" will have to account for the remarkable coincidence between the date of the Hyksos expulsion and that of Jacob's birth.

The merest glance at the book shows that Mr. Schmidt has built his book up entirely, in our opinion, from the works of Egyptologists, and yet he does not wish to "weaken the effect of the facts presented" by encumbering the text with a mass of miscellaneous citations from so-called "authorities," an ingenious way of avoiding the publication of his vast indebtedness. He is not content with setting Egyptian chronology on a firm base, but he wishes to take a prominent position as an exponent of the vexed Mycenæan question, for he tells us quite gravely that the "Ionians (*Ia-nim*) were settled in the Grecian Archipelago and on the adjoining shores of Greece and Asia Minor as far back as the reign of Teta, or 3146 B.C."! It has been necessary to select the above statements from Mr. Schmidt's preface so that the reader may know the manner and style of the book which he has to deal with; but before we attempt to summarise the general contents we must point out that the industrious author of this remarkable compilation seems to have been mistaken on certain important points. To begin with, all the evidence which has been derived from prehistoric sites in Egypt during the last six years proves conclusively that the first three dynasties are historical facts, and no competent Egyptologist ever doubted the existence of the kings who belonged to them. It is clear, from the remarks which Mr. Schmidt makes in his preface, that he does not know enough Egyptology to decide what authority to follow. Egyptologists have for a generation or more declared the great antiquity of Egyptian civilisation, and it is only the semi-religious and pseudo-scientific writers on Egyptian history who have been too biased to see the light; the writings of some of the latter must form the slain enemies whom Mr. Schmidt sets out to slay again. Had Mr. Schmidt read M. J. de Morgan's "Recherches Préhistoriques," which were published in 1896 and 1897, he would have seen that Egyptian civilisation must be thousands of years older than he supposes; and it is possible that he would have kept his work in manuscript. Sir Norman Lockyer has proclaimed, in his "Dawn of Astronomy," with no uncertain voice the great antiquity of Egyptian civilisation, and, what is more, his facts have never yet been controverted; but we see no mention of the results achieved by de Morgan and Lockyer, or even any indication that they are known to him in Mr. Schmidt's book. We have no wish to belittle the work of any pioneer in archæology, but when we see Mr. Schmidt solemnly quoting Canon Rawlinson's *old* publications on Egyptian chronology we feel sure that he does not know how to select his authorities; and if he refers to excellent and, according to their bias, honest men like Canon Rawlinson as "authorities," it proves conclusively that he does not know what an Egyptologist is.

Mr. Schmidt divides his book into two parts, which are preceded by a preface, from which we have already quoted, and by an introduction; in the first part, he deals with the Sothiac (*sic*) system of chronology and the lists of Manetho, the Twelve Months, the Signs of the Zodiac, the formation of the Solar System, the present state of Egyptian chronology, the Sothiac (*sic*) year, Manetho, the chronological numbers in Josephus, &c. In each of these sections he lays down the law in an arbitrary manner, and he incorporates in his paragraphs a number of remarks which appear to us as irrelevant. In the second part, he discusses one dynasty after the other, and accepts what suits his own views in the writings of ancient and modern authors, and rejects as worthless what he cannot explain in their works. We have read the book with some care, but have not yet found the "startling discoveries" which Mr. Schmidt professes to have made, and we have failed to see how his chronological history is "self-verifying." We are familiar with the Sothic year, and the manner in which it has been applied to the elucidation of Egyptian chronology; but as different investigators, though using the same data concerning the rising of Sothis, arrive at different results, we feel that its correct application is not in all cases sufficiently understood. No one doubts that the Egyptians were astronomers of no mean order, and in recent years Sir Norman Lockyer has shown us what an integral part of their religious system the knowledge required for orienting temples was; but more would be known of their astronomical knowledge if the astronomical texts could be fully

understood in these days, and it is impossible to assign correct meanings to them until we know the exact signification of every word which occurs in them.

The weak part of Mr. Schmidt's argument is that, even supposing all his statements about dates in the Sothic year were correct and could be proved, he does not allow a sufficient number of Sothic years to cover the long period of years in which the Egyptian civilisation was evolved, and developed, and matured, and decayed; and it seems to us absurd to limit this period to three Sothic years, or 4380 ordinary years. Mr. Schmidt's system of chronology is worth no more than any other in which a large amount of "playing at doing sums" occurs, and he has merely put together in book form a series of notes and extracts from the works of Egyptologists, and from those of writers like Bunsen and Cory, which he has arranged according to his own peculiar views; the result is a perfectly unreadable volume of 569 pages, in which the "omissions" of one ancient authority and the "mistakes" of another are paraded in a bewildering manner. We have no wish to be flippant or to treat Mr. Schmidt's book in other than a serious manner, but his conclusions remind us forcibly of the result of the investigations into the date of the building of the Tower of Babel of the eminent English divine who declared that the "last brick was laid on the top stage of the Tower of Babel at Borsippa at 4 p.m. on Thursday, April 15, B.C. 2247." We cannot possess a continuous and accurate chronology of Egypt until we know how many kings reigned between Mena and Nectanebus, and how many years each reigned, and who succeeded whom; to make such a chronology at present is impossible because the necessary data do not exist. The writer who assigns precise dates to certain events in Egyptian history, *e.g.* the date B.C. 4244 to "the establishment of the kingdom," probably deserves to be considered either a "crank" or a charlatan, and in any case the presumption of the writer who asserts definitely that the Ionians were settled on the shores of "Greece and Asia Minor as far back as the reign of Teta, or 3146 B.C." is stupendous.

We are not reassured on the matter of Mr. Schmidt's scholarship when we find such blunders and spellings as the following: Puon-et, p. 7, *uae* (there is no such word) p. 9, Hyk-sat-u, p. 13, Rokchoris, p. 14, Tarako, p. 14, Sothiac, p. 16 and *passim*, Sopdet, p. 17, Uon-nofer, p. 20, Ânu, p. 27, Ach-i-u, Ta-ān-nut, p. 30, Pa-api, p. 35, Amen-em-het, p. 49, Rohk-nez, p. 52, Num, p. 61, Usertasen, p. 81, Quebahu, p. 105, the identification of Ta-ânut (*sic*) with This, the derivation of the Hebrew name "Adam" from that of Mena, the first historical king of Egypt (!), p. 117, Hus-et and Hus-ir, p. 122, Per-son, p. 131, Osiropis, p. 253, Zawyet-el-Arrian, p. 268, Elephantinæn, *ibid.*; this list might be increased almost indefinitely. Mr. Schmidt looks upon the story of the Flood as an allegory which he interprets thus. Noah was born B.C. 2948, and the Flood "broke loose" over the land B.C. 2348; Thebes became independent B.C. 2948, and the XIth, XIIth and XIIIth dynasties of kings reigned exactly 600 years, *i.e.* a period equal to the age of Noah when the Flood "broke loose." According to Mr. Schmidt the Flood was no flood of water, but an invasion of Hyksos, and the ark to which Noah and his family, &c., fled was nothing else than the city of Thebes, because the Hebrew word for ark is *Têbhâh*, and this, according to Mr. Schmidt, is the name of the city called Thebes. The sending forth of the dove from the ark is another part of the allegory, and means that Noah and his sons sent forth from Thebes messengers to the Hyksos offering their submission, which was duly accepted, and payment of tribute imposed upon them!

From reasoning of this kind the reader will easily be able to gauge Mr. Schmidt's qualifications as a reformer of the chronology of Egypt; as a final proof of the correctness of his views on this subject he points triumphantly to the fact that the fifteen cubits of height above the mountains which the waters reached at the time of the Flood refers to the depth of the waters of the annual Nile inundation, which he declares to be exactly fifteen cubits at Heliopolis! When he deals with Babylonian questions Mr. Schmidt is equally unfortunate, for on p. 545 he gravely refers to the discovery of a tablet "recording the war waged by Khammurabi against Eri-aku and his Elamite allies"; a reformer of Mr. Schmidt's pretensions should at least have shown that he had read that this "discovery" was exploded finally by Mr. L. W. King in the first volume of his "Letters of Khammurabi," published in 1898, for, as now stated by Mr. Schmidt, his arguments fall to the ground. Before he writes another book of "startling discoveries" we hope he will read the current literature of the subject, and will remember that assertion is not evidence, and that theories and hypotheses are not proofs.

ELECTRO-CHEMISTRY.

Practical Electro-Chemistry. By G. Bertram Blount. Pp xi+374. (Westminster: A. Constable and Co., Ltd., 1901.) Price 15*s.* net.

ALTHOUGH the foundation on which electro-chemistry is built was to a large extent laid by the genius and splendid research work of two Englishmen, Davy and Faraday, and is practically based on the laws enunciated by the latter, yet to-day, when many branches of industrial chemistry are being revolutionised by the introduction of this branch of chemical science, we as a nation know practically nothing about it. In America we are confronted by numerous works upon the subject; if we turn to Germany, there again we find a whole library of books devoted entirely to electro-chemical science and to its industrial application. Turning to our own country, what do we see? One or two books on electro-plating, books on electrical engineering, and a few *translations* of German works on electro-chemical analysis.

It was, therefore, with sincere pleasure and eager anticipation that one saw, in the publishers' announcements at the end of last year, that Messrs. Constable and Co. would shortly bring out a work on "Practical Electro-Chemistry," by Mr. Bertram Blount. The book which is now published consists of eight sections devoted to different branches of electro-chemistry.

The first, or introductory, section treats in an interesting manner of electrolysis and more or less of the theory of solution. A useful subsection is also given on the "Method of calculating output in electrolytic processes." After discussing at no very great length a particular

case, viz. that of the electrolysis of fused sodium chloride, Mr. Blount says:

"Thus in practice he who is firmly grounded in these primary principles can deal with each particular case as it arises, not experimenting blindly, but with certain definite and exact generalisations to guide him."

This is very true, but the example taken is one in which the course of reaction is very readily followed out, and although we presume Mr. Blount does not profess to deal exhaustively with this phase of the subject, yet the section would have been much more instructive if Mr. Blount had also included an example where the main reactions are masked by secondary changes.

The next section deals with "Winning and refining of metals by electrolytic means in aqueous solutions." To the winning and refining of copper as being "the largest of all electrolytic industries" is assigned the chief place. The author has failed to treat this part of the subject with sufficient breadth. There are two main methods for obtaining copper electrolytically—the multiple system, in which the anodes and kathodes are suspended opposite to each other, and the series or Hayden system, in which at one end of the vat there is an anode plate, at the other end a kathode plate, the intervening space being occupied with plates of the same quality as the anode plate. These plates function both as anode and kathode, the surface opposite the anode acting as kathode, that opposite the kathode as anode. Mr. Blount has dealt fairly fully with the multiple system, but only very shortly with the Hayden system, which he condemns, hardly, however, giving sufficient evidence for his condemnation. Surely, also, a little more space might profitably have been devoted to the treatment of the anode sludge, the successful working up of which often goes a long way towards making an electrolytic process a paying one.

On p. 125, with reference to the difficulties met with in obtaining nickel in a state of purity, the author gives this useful warning:

"The study of the degree of purification effected by the electrolytic refining of nickel is particularly instructive, and should suffice to dispose of, once for all, the ridiculous belief that a metal prepared by electrolysis is necessarily and *ipso facto* of unusual purity."

The author is hardly correct in saying that no serious attempt appears to have been made to refine tin electrolytically. He is evidently unaware that a patent has been taken out by Mr. Claus for refining impure tin. In Mr. Claus's process, tin cast into plates is made the anode in a bath of sodium sulphide, the kathode being of tinned iron. The impurities, as well as gold and silver, remain in the anode sludge, and tin is deposited in a very high state of purity at the kathode.

Probably the third section, which treats of the electrolysis of fused salts, will be of most interest to the general reader, seeing that under this head the production of aluminium is naturally dealt with. The short section on the electric furnace, carbides and the researches of Moissan, which follows, will repay perusal, if only by pointing out the vast fields of research which the introduction of electricity to chemical processes has opened up.

Section vi., which is assigned to alkali, chlorine and their products, is extremely disappointing. This branch is, perhaps, one of the most important in the whole range of electro-chemistry, and should therefore have been treated comprehensively. The production of chlorine and caustic soda by electrolysis of common salt receives somewhat exhaustive treatment. But the important, much-worked-at and widely-debated subject of hypochlorites and chlorates, together with the practical and theoretical causes which underlie these processes, are handled most inadequately. The casual reader would carry away the impression that if a cold solution of a chloride is electrolysed without a diaphragm, a solution of a hypochlorite will be produced, but that on electrolysing at high temperatures a chlorate will be obtained. Unfortunately, the electrolysis of a chloride is by no means so simple. There is a very large amount of literature on the subject, and if Mr. Blount had endeavoured to summarise the various methods and the theories advanced, this section would have been very valuable, but he has unfortunately failed to do this.

The part devoted to electrolysis of organic compounds is short, and therefore it would be rash to expect too much from it.

The book as a whole is eminently readable, but it is doubtful whether it will be of much value to the manufacturer or practical chemist. But, in fairness to the author, let us not forget that it is extremely difficult to obtain trustworthy and authentic information of manufacturing processes; the main facts may be published, but it is often the seemingly unimportant details which make or mar a process. The value of the work to the scientific reader would have been greatly enhanced if the author had given references to the original literature from which he obtained his information. To general chemical students the book, although not entirely up to date, may be recommended, in that it deals with the newest of chemical industries in an interesting manner, and will perhaps induce some of the younger chemists to engage in this important branch of study.

F. MOLLWO PERKIN.

SCLATER'S MAMMALS OF SOUTH AFRICA.

The Mammals of South Africa. By W. L. Sclater. Vol. ii. Pp. xii+241. Illustrated. (London: Porter, 1901.)

THE first volume of this important work having been already reviewed in these columns, and its main scope and style referred to, our notice of the second and concluding volume may be comparatively brief, especially as it is chiefly devoted to the smaller mammals, such as rodents, bats and insectivora, which command a much smaller sphere of general interest than is the case with their larger terrestrial relatives.

In describing the rodents and bats, the author has been confronted with a task of considerable difficulty on account of having access to the types of many species only during short and busy visits to England. Consequently a considerable portion of this section of the work partakes in some degree of the nature of a compilation; and Mr. Sclater himself would probably be among the first to admit that some amount of revision will have to take place in the future with regard

to certain species and genera. When, however, these great difficulties are taken into account, it must be allowed that the author has fulfilled his task in a highly creditable and satisfactory manner.

And as regards nomenclature, classification and the splitting-up of certain old, unwieldy generic groups like the squirrels into divisions of smaller size, Mr. Sclater is well abreast of modern ideas. One of the most noticeable of these modern changes in classification is the transference of the so-called Cape jumping-hare—the spring-haas of the Boers, from its old association with the jerboas—to a position near the cane-rat and the porcupines. Nor is this all that is noteworthy in Mr. Sclater's remarks on the creature; for we are told that, in spite of the huge bounds it takes, "it is never very rapid in its movements, and can be easily overtaken." This information we have not found given in any of the other works to which we have turned. It is a matter for regret that the portrait of the spring-haas, like many of the other figures in the book, has not been executed in a more satisfactory style.

An old error—to wit, that it burrows—in connection with the cane-rat is also corrected, mainly on the evidence of the late Prof. Peters and Captain Drummond.

Among the most curious and interesting of all the smaller mammals of South Africa are the elephant-shrews, or jumping shrews, and the golden moles, and of each of these Mr. Sclater gives an excellent account, both as regards bodily characteristics and habits, although further observations are stated to be required with regard to the mode of life of the last-mentioned animal.

"The golden mole," writes the author, "is exceedingly common in gardens, where it makes runs in all directions in search of the worms and grubs on which it lives. Although generally supposed to be destructive, it is really a great aid to the gardener, as it destroys quantities of larvæ, especially those of a certain gamma moth. . . . A certain amount of mischief, however, is done by the mole in pursuit of its prey by disturbance of roots and freshly-sewn seeds."

In addition to the Rodentia, Chiroptera and Insectivora, the present volume also includes the South African Cetacea and Edentata. Among the cetaceans special interest attaches to the author's description of a specimen of the lesser sperm-whale recently taken in Table Bay, as the external characters of this rare whale have been hitherto very imperfectly known. Of the specimen in question Mr. Sclater gives a sketch, which shows the characteristic shark-like mouth and small dorsal fin. Certain differences in size which have been thought to indicate specific distinction are, in the author's opinion, probably due to difference of sex in the individuals which have from time to time been examined.

The aard-vark and the pangolin Mr. Sclater, although with some hesitation, still retains in the same order with the typical South American Edentata. And it must be confessed that certain observations which have recently been made with regard to the myology of these creatures tends, so far as it goes, to justify this conservatism. Whether there really is any close relationship between the two groups is a question of the very highest importance in regard to certain views that have been recently expressed in favour of a former connection between Africa and South America. And it would greatly help matters if a decisive answer could be given on this point.

Mr. Sclater may be congratulated on the completion of a very important and valuable work. R. L.

INFINITESIMAL GEOMETRY.

Einführung in die Theorie der Curven in der Ebene und im Raume. By Dr. Georg Scheffers. Pp. viii + 360. (Leipzig: Veit and Co., 1901.) M. 10.

THIS volume is the first of two which will make a complete work under the title "Anwendung der Differential- und Integral-Rechnung auf Geometrie." The subject-matter of the two volumes may be said to be, roughly, the infinitesimal geometry of curves and surfaces respectively. The first volume is divided into three sections, dealing with plane curves, curves in space, and developable surfaces. The first section does not attempt to be a complete exposition of the subject, and must be regarded as an introduction to what follows, intended to accustom readers who are already well grounded in differential and integral calculus to the style and methods which are employed later. The theory of the curvature of plane curves is based on the definition of contact of an assigned order, which is explained with great exactness. The differential invariants of a curve for the group of movements in the plane are fully investigated, and their properties established in an elementary manner without introducing notions of groups or partial differential equations. Envelopes, evolutes, singular points, and the geometrical significance of differential equations of the first order and degree are discussed shortly. In connection with the trajectories of a family of curves, the problem is completely solved of finding all curves for which the product of the normal and radius of curvature is constant. The remainder of the first section is devoted to an explanation of curvilinear coordinates.

The second section contains a thorough and systematic account of the curvature, torsion, and allied theory of curves in space. The dual interpretation of an orthogonal substitution of coordinates as a change of frame of reference and as a movement in space is first carefully explained, and the theory of the intrinsic properties of curves is built upon it. Particularly interesting are the discussions of the differential invariants and of the integration of the intrinsic equations of a curve, in the course of which an elementary account of Riccati's equation is given. Conditions for contact of an assigned order are carefully laid down, and from them the relations between a curve and its osculating circle and helices are deduced; in particular we have the interesting result that the axes of all osculating helices at any point generate a cylindroid.

In the third section the main properties of the surface generated by the tangents to a curve are established. The general ruled surface is introduced in order to provide a rigorous investigation of what is meant by saying that consecutive generators intersect. The remainder of the section is occupied with various loci connected with a given curve, such as evolutes, involutes, parallel curves, polar surface, rectifying surface, etc. The text ends with a short account of minimal lines and minimal curves.

Few points in this book call for adverse criticism. In determining the motion of the frame consisting of tangent, normal and binormal at any point of a curve, it would be clearer to introduce the curvature and torsion into the general formulæ for moving axes as measures of small rotations, and it would be more convenient to make a positive torsion correspond to a positive rotation (in this connection the English reader may be warned that the term "rechts-gewunden" is applied to what we should call a "left-handed" screw). It is surprising that no general method is given for expanding the coordinates in powers of the arc; the employment of these expansions very much simplifies the investigation of osculating helices and of the osculating cone, and can hardly be objected to on the ground of being a "Kunstgriff."

The book is written in a very pleasing style, with that light and clear touch which we are accustomed to associate with French writers, and except in one or two instances the analysis is very judiciously handled. For soundness it leaves nothing to be desired and its incompleteness is only an incentive to deeper research into the subject. Specially commendable are the careful explanations of points which are usually slurred over. A distinct feature is the introduction of imaginary quantities at an early stage and the discussion of exceptional cases that arise in connection with minimal lines and curves. The whole book is pervaded by the ideas which are associated with the name of the author's great master, Sophus Lie.

The type is clear and good, misprints seldom occur, and the figures are excellent. The practice of giving two or three orthogonal projections instead of one figure in perspective is much to be commended as a means of conveying exact information and of training the student to build up a mental conception of a figure in three dimensions.

The second volume, which is promised in the course of next year, will be awaited with the greatest interest.

R. W. H. T. H.

OUR BOOK SHELF.

Les Phénomènes electriques et leurs Applications. By H. Vivarez. Pp. vi + 574. (Paris: Carré and Naud, 1901.) Price Fr. 15.

M. VIVAREZ'S book covers almost the whole field of modern electrical practice in a manner which is neither too technical nor too popular. The daily increasing applications of electricity in the industries and arts render such a book valuable in two ways. In the first place, it should appeal to the ordinary engineer, manufacturer or man of science who finds himself obliged to make use of electricity in some way or other, and who can turn to its pages for general information on the subject. Secondly, the electrical engineer is generally obliged nowadays to become a specialist in some particular branch of his profession, and is liable, in consequence, to get out of touch with other branches with which it is desirable he should have a general, if not a detailed, acquaintance. Such he can obtain from a book of this kind. M. Vivarez has set out with the object of supplying the wants of these persons, and also, doubtless, the want of the intelligent amateur who is anxious to keep pace with modern industrial progress, and he has, we think, succeeded admirably in his endeavour. He has produced a book which is thoroughly readable and interesting, and is not at all overladen with calculation or technical detail. Perhaps in some cases he has shown rather a tendency to skip over the less interesting parts at a sacrifice of clearness, as, for example, in the section on units. This may not be of much importance to the electrician who will have obtained his fundamental conceptions elsewhere, but it is a great disadvantage to the non-electrical reader, who can never properly understand the subject unless his knowledge of the groundwork be sound—a truth he is himself too prone to ignore.

In a book of this kind a great deal depends on the proper proportioning of the space allotted to the various subjects considered. On the whole, M. Vivarez has divided his space very fairly, though he has given rather an undue preponderance to the more modern "engineering" developments. More space should, we think, have been devoted to telegraphy, which is at once the oldest and the most important application of electricity; electrochemistry and metallurgy are also treated somewhat too briefly. We looked in vain, also, for any description of vacuum tubes; their omission is unfortunate, seeing of what value they have become to mankind since Röntgen's discovery. The X-ray may have passed rather from the hands of the electrician to those of the surgeon, but it remains, all the same, an important "phénomène électrique."

The most interesting portions of the book, to our mind, are the historical parts. M. Vivarez has given a brief historical account of all the important developments, and has carried this to the extent of even giving a short history of the industrial employment of coal. These historical summaries are both interesting and valuable, the more so as this is a side of science too frequently neglected. Is it because the development is so rapid that the history cannot keep pace with it, or, as we are inclined to believe, because of the natural antipathy of the average engineer to anything that tends to be literary? In any case, there can be no doubt that many engineers will be found ignorant, not only of the works, but even of the names of the men who have made their profession, and for this reason we would recommend the book before us to the student of electrical engineering; it will show him the importance of the work of the man of science, and may bear useful fruit in inducing him to read original papers.

The Agricultural Changes and Laying Down Land to Grass. By R. H. Elliott, 2nd edition. Pp. xii + 101. (Kelso: J. and J. H. Rutherford, 1901.)

MR. ELLIOTT has for some years been pursuing a system of agriculture on his estate in Roxburgh, the essential feature of which is that he secures a thick turf by the use of heavy seedlings of the stronger grasses and other pasture plants, and after half a dozen years or so humus has accumulated to such an extent that the land may be put through a course of tillage cultivation without the use of any fertiliser but artificial manures. The seed-mixture that he uses is characterised not only by its abundance, but also by the fact that it contains the seeds of such out-of-the-way plants as burnet and chicory. Mr. Elliott is a firm believer in the ameliorative influence of deep roots on the subsoil, and certainly his pastures yield a large amount of food. He claims that the temporary leys secured under his system are much more profitable than "our two great enemies, turnips and cereals," and our national statistics show that many farmers are of the same opinion. The system has, no doubt, answered well in the comparatively cool and humid atmosphere of the Cheviot uplands, but whether it is capable of successful adoption in the drier dristricts of England is another matter. As Mr. Elliott has not put his system into competition with the ordinary methods of management of temporary grass land, it is impossible to say whether it is an improvement on general practice or not. Be this as it may, it does not

seem that the author has made out a case for the Board of Agriculture taking over his farm and converting it into a national object-lesson. It would be much cheaper, and quite as useful, to have his prescriptions tested on a practical scale in other parts of the country, and this the Board of Agriculture and the agricultural colleges might very well arrange to do.

Friederich Wöhler, Ein Jugendbildniss in Briefen an Hermann von Meyer. Edited by Georg W. A. Kahlbaum. Pp. 97. (Leipzig: J. A. Barth, 1900.) Price M. 2.40.

THESE letters were found amongst the Hermann von Meyer's bequest to the Munich Academy of Science, and Prof. Kahlbaum has done well by making them accessible to a larger circle in their present form.

Although A. W. v. Hofmann, in his charming work, "Zur Erinnerung an Vorangegangene Freunde" (Braunschweig: Vieweg und Sohn, 1888), has given a history of Wöhler's life, these letters to the intimate friend of his youth furnish a most interesting supplement to Hofmann's narrative, and will be particularly appreciated by the surviving pupils and friends who enjoyed the privilege of personal acquaintance with Wöhler, or the still larger number who now or in the future take an interest in the history of the early days of modern chemistry. This publication comprises letters covering but a short period, they are neither remarkable for style nor form, as they were obviously only intended for the person to whom they were addressed; but they are, perhaps, all the more valuable an this account, for they give a characteristic and life-like record. Prof. Kahlbaum, whilst scrupulously preserving the original text of the letters, has taken great pains in collecting additional information respecting the persons and places mentioned, and his copious footnotes afford a most useful framework to the letters, which in themselves give us so vivid a picture of the condition of things under which the ardent and youthful enthusiast pursued, with such eager devotion, his experiments and studies, and thus prepared himself for the high position he so soon attained amongst the leading chemists of his age. H. M.

Die Flora der Deutschen Schutz-gebiete in der Südsee. Von. Prof. Dr. Karl Schumann und Dr. Karl Lauterbach. Pp. xvi + 613, with 23 lithographic plates. Large octavo. (Leipzig: Gebr. Borntraeger, 1901.)

SINCE the acquisition of Kaiser Wilhelmsland and the neighbouring islands, German explorers and botanists have been busy working out the flora of their new possessions; and now, some seventeen years from the date of annexation, all available information is made accessible in the imposing volume under review. The immediate cause of the issue of this Flora is that the series of extensive collections that have recently come to hand necessitated a considerable volume for their adequate description. This, and the fact that the literature on the flora is much scattered, has prompted the authors to expand their undertaking so as to include the results of earlier explorations. The area dealt with includes, besides Kaiser Wilhelmsland (German New Guinea), the adjacent Bismarck Archipelago, the more westerly of the Solomon Islands, the Marshall, Caroline and Marianne Islands. In all over 2200 species are enumerated, and of these 400 are described for the first time, or have become known only from the recent collections which have led to the publication of this Flora. The species are distributed as follows:—Algæ, 222; Fungi and Lichens, 226; Bryophytes, 200; Pteridophytes, 155; Gymnosperms, 12; Monocotyledons, 392; Dicotyledons, 1000. The new forms are all fully described, whilst both for these and for all the plants enumerated, admirably full localities are given. Many of the new forms are of considerable interest, and fourteen new genera are created. There is a new species of *Cycas* occurring in the Bismarck Gebirge up to a height of 3000 ft., in habit resembling an Australian *Xanthorrhœa;* Guppy's interesting *Sararanga* (Pandanaceæ) is recorded with an extended distribution; there is a small Palm, *Dammera*, allied to *Licuala;* whilst among Dicotyledons, *Ficus arbuscula*, a fig-tree 3 to 6 feet high, may be mentioned. The new *Hibiscus papuanus* is spoken of as possessing the most strikingly beautiful flowers in the whole region. The additions to Rubiaceæ are considerable, and include *Dolicholobium Gertrudis* with curious dimorphic flowers. A second species of *Bothryocline* (Compositæ) considerably extends the distribution of a genus previously restricted to Africa. In *Psychotria myrmecophila*, from the Bismarck Gebirge, we have a new type of ant-plant with curious excavated trifid stipules, which appear to harbour ants in their recesses; its biological relations will require to be worked out on the spot.

The work contains, in addition to a brief introduction by Prof. Schumann, an interesting history of the botanical exploration of the whole region by Dr. Lauterbach, the enlightened director of the New Guinea Company. Included in the volume are twenty-three large plates, which adequately portray the characters of the more important novelties. Certainly the authors are to be congratulated upon their achievement, which is a model of what such a work should be. It will prove a boon to the local officials, colonists and missionaries, and cannot help but stimulate further research.

Fact and Fable in Psychology. By Joseph Jastrow. Pp. xi + 375. (Boston and New York: Houghton, Mifflin and Co., 1900.)

OF the eleven essays here reprinted the first seven are devoted to a common subject, viz. the so-called "occult" side of mental life and its significance for psychology. Prof. Jastrow's attitude towards the whole problem is marked by a luminous common sense which is, unfortunately, rarer even among serious psychologists than it should be. For scientific psychology the real question, as he never tires of pointing out, is not how to explain the marvels of spiritualism and allied arts, but how to account for the existence and wide diffusion of the state of mind which can believe in them. It is for the expert in conjuring tricks to show how the feats of the medium and the miracle-worker are done; the task of the psychologist is to investigate the "Psychology of Deception." Incidentally, however, such papers as Prof. Jastrow's essays on "The Psychology of Spiritualism" and "Hypnotism and its Antecedents," besides throwing light on the mental condition of the deceived, are interesting as showing how more than one famous occultist has executed his deceptions. The latter of the two papers just named brings out clearly and well the enormous difference between the spirit and methods of science and of superstition in dealing with one and the same set of facts. In the essay on "The Problems of Psychical Research" Prof. Jastrow is perhaps on more debatable ground, though his attitude seems to the present reviewer at least the only scientific one. Briefly his position may be summed up thus: the psychologist, as such, has no interest in the facts of "telepathy" except in so far as they throw light, as any facts about abnormal mental states may, on the known laws of normal mental processes. The "psychical researcher," on the other hand, thinks his facts sufficient warrant for postulating types of mental process of which normal life reveals nothing. Hence, unlike the psychologist, he approaches the facts in a non-scientific spirit. In a subsequent "Study of Involuntary Movements," conclusive experimental proof is given of the dependence of "thought-reading" performances upon unconscious movements of the muscles of the "subject" towards the object on which attention is directed. Of the remaining papers the most suggestive is perhaps that on "The Dreams of the Blind."

LETTER TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Selenium in Sulphuric Acid.

WITH reference to the article in NATURE on the beer poisoning epidemic (pp. 541–542) as to the possibility of the presence of selenium, either conjointly with or preferentially to some compound of arsenic producing the calamity, the following observations may be of interest.

Some few years ago, in the course of an investigation on the inertness of the alkaline earths towards hydrochloric acid gas (*Ber. Deutsch. Chem. Ges.* xxix. 577–580), I had occasion to use sulphuric acid (labelled *puriss*) as a dehydrating agent for the gas, but after passage of the gas for some time a red deposit of selenium was invariably observed at the bottom of the Drechsel wash-bottle containing the acid.

It would, of course, be impossible now to trace the past history of such samples of acid, which might have come from several manufacturers, but these observations may show that selenium is a far more common impurity even in the best samples of acid than hitherto supposed.

Though some of the ill-informed writers and politicians of to-day might be invited, as a form of hard labour, to obtain sulphuric or any other acid in a state of purity (*credite experto*), yet it is not apparent that this acid need be used for the preparation of invert sugar to be subsequently applied to the manufacture of beer.

V. H. VELEY.

Oxford, April 6.

THE BOARD OF TRADE AND ELECTRIC LIGHTING.

THE Board of Trade has been busily engaged during the past few weeks with two inquiries of great importance to the electric lighting industry. The decision arrived at in the one of these which dealt with the maximum price to be charged for electric energy has already been referred to in our issue of March 14 (p. 474). The other inquiry, which was opened on March 1 under the presidency of Sir Courtenay Boyle, occupied the attention of the Board of Trade for six days, and has raised some points of considerable technical and scientific interest. The Board has not, as yet, given its decision, but the hearing of evidence and the pleadings have been completed, and we propose briefly to review the expert evidence in the following article.

The object of the inquiry was to consider an application to the Board of Trade, made by various electric lighting companies and local authorities, notably by the Westminster Electric Supply Corporation, for an alteration in one of the Board of Trade regulations. The regulation in question provided that "no change should be made in the pressure of the supply to any premises . . . except with the consent of the consumer." This regulation, it will be seen, gives to the consumer the absolute power to veto any change in the standard pressure of the supply to his premises, a change, for example, from 100 volts to 200 volts, which the supply company may desire to make. It was this power of veto that the companies wished to remove, and accordingly they made application for an alteration of the regulation by which for the words "with the consent of the consumer" should be substituted the words "on such terms and conditions as may be agreed upon between the undertakers and consumer, or, failing agreement, as may be settled by an arbitrator appointed by the Board of Trade," or words to that effect.

The difficulties which have led to this inquiry have all arisen out of the change from a 100-volt to a 200-volt supply which is being made by the Westminster and other electric light supply companies. The change was started in the case of the Westminster Corporation, which we may take as a typical instance, in 1896, and their reasons for making it were as follows. The system, as originally laid down, was a three wire system with 100 volts between each outer conductor and the middle; by 1895 the demand for electric light had increased so much that the street mains were beginning to get overloaded, that is to say, the current which they were obliged to carry was more than was economically good. The evil of this overloading was shown in two ways: on account of the heavy current which the mains were carrying the loss of energy in them, which is proportional to the square of the current, was very great, amounting, in fact, to about 12½ per cent. of the total output; also the drop of voltage in the mains was considerable and made it increasingly difficult to maintain the voltage at the consumer's terminals within the limits of variation allowed by the Board of Trade. In these circumstances, the supply company was faced with a difficulty which could be overcome only in two ways. Either they could put down fresh mains year by year to meet the increasing demand, a proceeding which would involve an expenditure of something like 7500*l*. a year, or they could supply the same amount of energy, using a smaller current and a higher voltage. If the voltage were doubled the same amount of energy would be supplied by only half the current, and the energy loss in the mains would be only one-quarter of its former amount; the drop of voltage would at the same time be halved (the percentage drop being therefore only one-quarter of its former value), and thus the second difficulty referred to above would be avoided. It is perfectly evident, therefore, that from the supply company's point of view the best course to adopt was to increase the standard voltage of the supply. And indirectly, also, this course must be beneficial to the consumers, and prospective consumers, for anything that tends to cheapen the cost of supply to the company tends also to lower the price the consumer has to pay for the energy he uses.

The consumer has, however, another way in which he can look at the question. It is not simply energy that he wishes to buy, but energy that can be economically converted into light; in fact, he really wants simply to purchase light. If, therefore, the 200-volt lamp is less efficient than the 100-volt lamp, it may be to his disadvantage to have to use energy at 200 volts, even though the cost of such energy may be less. For example, if we may state a similar case, it is not an advantage to a consumer to be obliged to drink arsenical beer, although the cost may be less than that of pure beer. In addition, the change necessitates, in most cases, refitting and rewiring of the premises, since the fittings that are suitable for 100 volts, especially if they are of old patterns, are not good enough for 200 volts, and also the wiring is often not good enough for the higher pressure. The question of the liability of the supply company for the costs of these alterations and for the inconvenience caused by the necessity of making them is, however, one which can reasonably be settled by arbitration. The matter of prime importance to the consumer is, we consider, the question of the inferiority—real or alleged—of the light obtained with 200-volt lamps.

Before the Westminster Corporation decided to make the change, they ascertained to their own satisfaction that the 200-volt lamps were as good as the 100-volt, or, if not as good, so little inferior that the disadvantage was more than counterbalanced by the lowering of the price charged to the consumer. This is a point, however, on which doctors disagree, as was shown by the expert

evidence at the inquiry, and it is interesting to note the grounds given for the various opinions held.

Prof. Kennedy, who is adviser to the Westminster Corporation, advanced the argument that if the 200-volt lamp were really less efficient than the 100-volt, then the consumption of energy per lamp connected to the mains should have steadily increased since 1897, as more and more consumers were changed over to the higher pressure. But this argument is, as Prof. Ayrton pointed out, quite fallacious; if the consumer is supplied with a 200-volt so-called 8 c.p. lamp, which is, in reality (as in an actual case quoted by Prof. Ayrton), only giving a candle-power of 1·8 and is consuming 15·3 watts per candle, it will only consume 28 watts; the consumption of energy is therefore rather less than with a 100-volt 8 c.p. lamp giving its correct candle-power and consuming 4 watts per candle. The consumption of energy per lamp in cases like this goes down, from which Prof. Kennedy would argue that the efficiency has gone up; whereas, as a matter of fact, it has diminished enormously, the effect appearing, not in an increased bill, but in a decrease of light. As a matter of fact, this is the way in which the inefficient lamps show their badness; they do not maintain their correct candle-power and take more watts, but they fall off in candle-power for the same consumption of energy. This was exemplified in the evidence given by Mr. B. M. Drake. Most engineers and lamp-makers call the watts consumed per candle by the lamp its efficiency, though, as a matter of fact, this quantity is a measure of the inefficiency. Mr. Drake prefers to measure the inefficiency by the complaints received per customer, and there can be no doubt that, though unscientific, this is a very good way of getting at an average value. According to this standard, Mr. Drake finds that the 200-volt lamp is much inferior to the 100-volt.

There was not wanting evidence in favour of the 200-volt lamp, but the majority of the experts, certainly in the cases in which the results of actual tests were given, were against it. To take one other instance, Mr. Gunyon, on behalf of the London County Council, gave evidence to the effect that the 200-volt lamp cost more, lasted for fewer hours, and was less efficient than the 100-volt; he gave the results of tests on four different makes of 200-volt lamps, the average consumption of energy in the *new* lamps coming out at 5·4, 4·1, 5·8 and 5·6 watts per candle respectively, the good value (4·1) being for a foreign make of lamps. These figures show that lamp-makers have by no means yet got over the difficulties of the manufacture of the 200-volt lamp which were pointed out by Mr. Byng in a paper read before the Institution of Electrical Engineers three years ago (*Journal* of the Institution of Electrical Engineers, 1898, vol. xxvii. p. 118). That they will ultimately triumph over the difficulties all must hope; that they have satisfactorily done so now cannot, we think, be maintained.

The inferiority of the high-voltage lamp is, however, as we have pointed out, not the only consideration; the change is, without doubt, beneficial to the supply company, and it must, moreover, be remembered that in many cases the change has been all but completely carried out. The Westminster Corporation have only some half a dozen consumers who are still being supplied at the low pressure; the remainder, either through choice, through indifference, or through ignorance of their power to refuse, have submitted to the change. No doubt these few outstanding consumers are an annoyance to the company and a source, possibly, of loss, although the company have raised the price they are charging them to the maximum allowable; yet we cannot help sympathising with the consumer who objects to being compelled to use what he honestly, and with justice, believes to be a worse article.

SEISMOLOGY IN JAPAN.

THE chief interest attached to the publications mentioned below[1] is the fact that while giving us an insight into the attitude taken by the Government of Japan in regard to seismology, they form an important link in the history of the modern development of that subject.

On February 22, 1880, a rather severe earthquake so far excited the curiosity of the inhabitants of Tokyo and Yokohama that, with the object of studying such tremblings, a Seismological Society was founded. This society existed for twelve years and published twenty volumes. The usefulness of its work, attracting the attention of the Japanese Government, led to the establishment of a chair of seismology at the Imperial University, and the organising of a bureau which now controls nearly 1000 observing stations. The next great stimulus that seismology received came from the terrible disaster of October 28, 1891. Ten thousand persons were killed, more than fifteen thousand were wounded, and thirty million dollars' worth of property were destroyed. A comparison of the buildings which remained standing with those which were shattered and those which were utterly ruined indicated that something might be done to minimise such disasters, and to accomplish this, by virtue of an Imperial Ordinance, on June 25, 1892, an Earthquake Investigation Committee was established. This body consists of some twenty-eight members selected from amongst the best-known engineers, architects and men of science in Japan. Two well-known names—Prof. D. Kikuchi and Dr. F. Ōmori—appear as president and secretary. The *modus vivendi*, which can be seen in the Parliamentary Budget, seems to have an annual variation of from 1000*l*. to 5000*l*. Amongst the various investigations which this committee proposed to undertake we find the following:—

To collect documents relating to seismology and volcanology; to draw up a statistical account of seismic phenomena in Japan, such, for example, as might be required by insurance companies whose risks extend to disasters caused by earthquakes; to conduct geological researches bearing upon seismology; to extend our knowledge respecting the nature of earthquake motion; to determine the velocities with which earthquakes are propagated from point to point; to make observations on changes in the vertical and earth "pulsations"; to compare the movements resulting from given earthquakes as recorded on the surface of the earth and at depths which are comparable with the depths to which foundations of buildings may be carried; to extend observations on the variability of magnetic elements, there being reasons to believe that these may hold a certain relationship to seismic activities; to observe changes in temperature at great depths; to determine strength constants for building materials produced in Japan; to measure accelerations and maximum velocities necessary for the shattering, overturning or projection of various bodies, amongst which no less than sixteen types of model houses are specified; to erect buildings specially designed to resist earthquakes; to study the effects of earthquakes on modern construction; and generally the committee undertook to make any investigation which may ultimately result in reducing the loss of life and property which so frequently accompanies violent earthquakes.

Although only nine years have elapsed since this elaborate programme was formulated, every item in it has received serious attention.

From volumes iii. and iv. we see that Profs. Tanabe and Mano have worked at the strength constants of

[1] Publications of the Earthquake Investigation Committee in Foreign Languages. No. 3, pp. 103; No. 4, pp. 141; No. 5, pp. 82; and No. 6, pp. 181. (Tokyo, 1900–1901.)

building materials, and investigated the effects of several earthquakes upon tall chimneys. Dr. B. Koto has handed to the committee twenty-two papers on geological subjects connected with seismology and volcanology. Dr. H. Nagaoka gives a paper of intense interest to all physicists on the determination of the elastic constants of rocks; whilst the well-known professor of seismology, Dr. F. Ōmori, contributes six papers, each of importance to seismologists, and for the most part indispensable to those who have to construct in earthquake countries.

Volumes v. and vi., which contain the analysis of the diagrams of 246 earthquakes observed in Tokyo between July 1898 and December 1899, are entirely from Dr. Ōmori's pen, and although we may not concur in all the results he sets before us, seismologists in general must thank him for the vast quantity of material which he has brought together and systematised for their consideration. For the earthquakes which originated at great distances from Japan, so far as possible each seismogram has been divided into parts which succeed each other in the following order: "First preliminary tremors," in which waves of 4 seconds period are superimposed upon those of 8 seconds; "second preliminary tremors," with periods of 8 seconds, and accompanied by undulations of 14, 25 and 66 seconds period; "the principal portion" of the earthquake, which is divided into three phases also dependent on period, and finally the "end portion," in which period is fairly regular. The regularity of the terminal vibrations may, as Dr. Ōmori remarks, be explained on the assumption that different portions of the earth's crust have particular periods of free oscillation. The discussion of these various types of earthquake motion is based on the assumption that the waves recorded are *horizontal movements and not tiltings of the ground.*

One observation which led Dr. Ōmori to take this view is that he has obtained seismograms which show that the amplitude of motion depends upon the multiplication ratio of the writing pointers attached to his pendulums, and not upon their sensibility to tilting. In addition to this he points out that if the undulations recorded were due to tilting, then the accelerations involved are such that our sense of feeling should be affected, which is not the case. Since Dr. A. Cancani, in 1893, drew attention to the fact that calculations based on a knowledge of the period, velocity and maximum tiltings of these unfelt undulations led to the conclusion that the inhabitants of the world were raised and lowered two or three feet hundreds of times per annum and had never observed the same, seismologists have regarded with suspicion the elements in the calculations leading to these results. Notwithstanding this, when we have so very much evidence of turbulent wave-like motion in and around epifocal districts, and evidence of repeated tiltings at distances of several hundred miles from the same, it is difficult to escape from the conclusion that similar but slower period movements may be propagated, like a swell upon an ocean, to very distant places, and seismographic pendulums be caused to swing.

Dr. Ōmori has certainly thrown new light upon the nature of the large waves, and it does not seem improbable that investigations carried out upon other lines may, if not completely at least partially, confirm his views.

A more debatable subject touched upon relates to paths followed by earthquake waves through the earth's crust. Because the velocity of the quick period phase of the large waves nearly equals that of local earthquakes, it is assumed that the former, like the latter, are propagated along the surface of the earth's crust, whilst waves which precede them travel at some small depth in the same. Inasmuch as the first preliminary tremors have, at a given station, a duration proportional to the arcual distance of this station from the origin of the earthquake, Dr. Ōmori thinks it likely that they are transmitted along paths nearly parallel to the surface of the earth, and at a probably constant depth.

Several sections in vol. v. refer to subjects which are not seismic, although they are of great interest to those engaged in certain branches of physical research. For example, references are made to the effect of slight loads upon masonry structures, whilst "oscillations of the ground," whose origin is not seismic, are discussed at some length. That we have for years past been acquainted with movements of pendulums and balances not proper to those of the instruments themselves, which may continue for hours or days, suggests the question whether we are not here being re-introduced to an old enemy in a new dress. Are these movements due to those of the ground or to local movements in the atmosphere? Can Dr. Ōmori assure us that similar instruments, placed in different rooms or under conditions which are different with regard to temperature and ventilation, behave similarly? If this be the case, then the distinction which has so frequently been drawn between "pulsations" and "air tremors" will be more clearly established. In a stable at Shide "air tremor" effects are, at certain seasons, frequent, whilst at times pendulums with a 15 seconds period will yield diagrams showing that they have been moving regularly with a period of two or three minutes. In an adjoining coach-house these movements are absent, and similar phenomena are common to Tokyo and other places.

What has here been said indicates the nature of the work now in progress in Dai Nippon, a complete account of which is to be found in thirty-two well-illustrated quarto volumes, which, unfortunately for Europeans, are written in Chinese characters. These volumes are with but little doubt one of the greatest store-houses extant of information relating to practical seismology, and as such it is to be hoped that an abstract, or at least a table, of their contents may be published in a European language.

As an example of their value we may select vols. xxii. and xxv., referring to an earthquake which in 1897 devastated North-Eastern India, and cost British investors and taxpayers several millions sterling. The first of these is by Dr. T. Nakamura, an architect, and it contrasts those forms of structure which withstood the effects of the earthquake with those which failed. The second, which treats of railway and bridge construction, is by Mr. T. Koyama, a railway engineer. These gentlemen are two out of four who were sent to India by their Government for the purpose of increasing their own extensive knowledge as to forms of structures most suitable for earthquake countries. On this occasion, as in others, special men were selected for special work, with the result that, not only has Japan profited by disasters of this character, but she has become a teacher of nations in practical seismology, and we, amongst others, may offer her thanks and congratulations on her efforts to save life and property.

J. Milne.

THE EYE IN THE RECENTLY DISCOVERED CAVE SALAMANDER OF TEXAS.[1]

The tailed Batrachia have during recent years attained an increased importance zoologically, by appreciation of the fact that in respect to many features in which their living representatives present a simplification of organisation they are retrograde. While but one of them possesses a complete maxillo-jugal arch, none are pentadactyle in both fore- and hind-limbs; and the unexpected has been reached, in the discovery that there

[1] "The Eyes of the Blind Vertebrates of North America," by C. H. Eigenmann (*Trans.* Americ. Microsc. Soc., vol. xxi. pp. 49-60), by C. H. Eigenmann and W. A. Denny (*Biological Bulletin*, Boston, U.S.A., vol. ii. pp. 33-40)

are no fewer than ten species of six genera which are lungless, and that in some of these respiration is largely buccal or pharyngeal, and may even, in all probability, involve the tips of the toes, as in *Autodax* and species of other known genera.

Conspicuous among recently discovered species are three of American origin which are cave-dwellers. Of these, one (a *Spelerpes*), occurring in the Mississippi Vale, has nondegenerate eyes; another (*Typhlotriton*), more restricted in the same region, has eyes which during growth undergo a recognisable degeneration. The third (*Typhlomolge*), discovered in 1896 in the underground waters of Texas, where it was obtained from an artesian well, said by our authors to be now thrown up at the rate of about fifty a year, is quite blind, possessed of functionless eyes. It is with the paper upon this genus that we have chiefly here to deal. The animal itself is of especial interest, as furnishing the much-desired American counterpart for the European *Proteus* long known. It differs from this, however, in being shorter bodied and longer limbed—so much so that the limbs appear by attenuation to have become converted into tactile organs—and the discovery that the eye is destitute of lens, rods and cones, and eye-muscles (which is the most interesting fact announced in these papers) is thus intensely significant, as it presents us among the Batrachia with a condition recalling that of the famous blind locust of the New Zealand caves, in which, under the functional atrophy of the eye, the antennæ have similarly become elongated and more important.

The second paper deals with the eye of the Mississippi cave salamander *Typhlotriton*, which, while "detecting its food by the sense of touch," shows only the first stages of that degeneration of the eye and its associated organs occurring in the Typhlomolge type. Both papers are illustrated, though very poorly, and they do not in this respect compare with previously published works on other blind animals which might be cited. Moreover, there is in the first paper an inexplicable error, for the senior author, stating that "the eye of Typhlotriton will be dealt with in another place" (*i.e.* the second paper herein quoted), continues erroneously to use this generic name in describing the Typhlomolge eye.

Typhlomolge is in every respect a most remarkable creature, as examination of the example preserved in our National Museum at South Kensington will show. The description of its eye, coming to us at a time when there has just been found (in the French Congo area) a frog in which the terminal phalanges of four of the hinder digits, perforating the overlying integument as do the ribs of the long-known Pleurodile Newt, project, freely and exposed, as sharply recurved claws. All this brings forcibly before us the lesson that in morphologically specialised forms of life, such as we are too apt to pooh-pooh, there are to be found facts which, on the whole, are among the most trustworthy, in enabling us to gauge the limits of nature's operations. Truly has Weismann remarked (as pointed out by the senior author in his 1899 Woods' Holl Lecture on "The Blind Fishes") that "an investigation into the history of degenerate forms often teaches us more of the causes of change in organic nature than can be learned by the study of the progressive ones."

G. B. H.

THE COMMERCIAL USES OF PEAT.

THE difficulty in obtaining coal for industrial purposes, and the high price that has had to be paid for it recently, especially where works are situated at long distances away from the mines, has led to more attention being paid to the use of peat for fuel. In the "Notes" of May 31, 1900 (vol. lxii. p. 108), a short description was given of the uses to which peat was being applied in Austria in the manufacture of textile fabrics. In a recent number of the *Engineer* (February 8, 1901) an account was also given of the peat fuel industry in Sweden. It is said that there is hardly any question of the day so prominent in that country as the use of peat fuel as a substitute for coal. The Government, recognising the importance of this matter, has appointed a Crown Peat Engineer, at a salary of 500*l*. a year, to survey the principal Crown peat bogs and to report upon the quality and suitability of the peat for use as fuel in locomotive engines. At several of the large works in Sweden peat is now used for generating steam. At the great Yungtell Metal Works and the Motala Shipbuilding Works, it is also used in generating furnace gases, the fuel being prepared by specially constructed works. At the former establishment, engines of 230 horse-power are supplied with steam generated by this fuel. In the province of Smaland a syndicate has recently purchased the peat bogs, from which it is estimated that a million tons of fuel will be produced in a year. At the Karpalund sugar refinery peat is now solely used for the nine boilers in use there of 100 horse-power each; the fuel being first converted into gas in generators in front of the boilers. This establishment has purchased an adjacent bog containing sufficient peat to supply the works for twenty years. The bog is connected with the factory by a Decauville railway. The furnaces were formerly fed by coal obtained from England, and a very great saving has been effected, the peat fuel costing less than half that of coal. On several of the railways peat is being tried as fuel for the locomotives with every promise of permanent success. There are several different kinds of machines for making this fuel. The process something resembles brick-making. The turf is cut from the bog either by manual labour or machinery, and stacked in summer to be air-dried, any remaining moisture being removed in heated drums or by centrifugals, and the peat is then compressed into briquettes. It is claimed that one ton of dried peat from the best class of bogs is equal to half a ton of English coal.

The largest area of peat in England is to be found in the Fen district, where it covers 600 square miles and the depth varies from 2 to 10 feet in thickness, and at Whittlesea Mere as much as 18 feet. Nearly the whole of the peat in the Fenland has been drained and is now cultivated.[1] In a few places in the Fens it is sun-dried and used for fuel. In the form of powder and mixed with carbolic acid it is also extensively used as a deodorant for earth closets and similar purposes, works for this purpose being established in Cambridgeshire.

There are also large deposits in the East Riding of Yorkshire along the valleys of the Trent and Ouse, Hatfield Chase covering 12,000 acres, where a manufactory has been for some years in existence for drying and preparing the peat for litter for stables and cow-houses. Its antiseptic properties make this litter very valuable, especially in large towns where straw is difficult to obtain. There are also large areas of peat in other parts of the country, as at Chatmoss in Lancashire and on Dartmoor.

In Ireland, the peat bogs cover about 5000 square miles, or about one-seventh of the whole country; some of the bogs are 43 feet deep, the average thickness being 26 feet. Occasionally, owing to an excess of water, the peat overflows the basin in which it is contained and flows over the cultivated land. Thus a few years ago the bog near Tullamore overflowed and covered nearly three square miles of land. Sun-dried peat is used in Ireland to a considerable extent for fuel. Some attempt has been made to work it for commercial purposes. The Irish Amelioration Society some years ago encouraged the conversion of it into charcoal, but the process was

[1] "The History of the Fens of South Lincolnshire." (London: Chapman and Hall.)

not found to pay commercially, although peat charcoal is well adapted for working and tempering iron for the finer kinds of cutlery. The Irish Peat Company erected extensive plant for drying and distilling the peat and producing tar, illuminating oil and paraffin. At these works, one ton of peat yielded 10 gallons of tar, or 28 lbs. of illuminating oil and 1 lb. of paraffin.

One of the last volumes of the Encyclopédie Scientifique, published in Paris,[1] is devoted to a treatise on peat and peat bogs. It describes the conditions under which peat was originally formed, the plants of which it is composed, the chemical analysis of its constituents, the principal bogs in Europe, the age of peat as deduced from the remains of animals, flint implements and tools found buried in it, the methods of obtaining and preparing peat for commercial purposes, the uses to which it is applied and its calorific value and antiseptic qualities.

W. H. WHEELER.

THE BRITISH AND GERMAN ANTARCTIC SHIPS.

THE two great Antarctic expeditions have made a stride towards completeness by the launch at Dundee and Kiel of the exploring ships *Discovery* and *Gauss*, both vessels built, at great expense, specially for service in the Antarctic ice. No complete official announcement of the organisation and programme of either expedition has yet been made. However, the two ships are afloat, and appear to be the finest vessels for ice-navigation ever constructed, not even excepting the *Fram*, which of course was planned for drifting with the ice-floes, not for sailing through them.

The following table compares the chief dimensions of the two vessels, so far as we have been able to ascertain them :—

	Discovery.	*Gauss.*
Length over all ... ... (feet) ...	—	168
,, at water line ... ,, ..	172	—
,, between perpendiculars ,, ...	—	151
Extreme Breadth ... ... ,, ...	34	35
Probable displacement fully loaded (tons)	1750	1450
Horse-power	450	300–500
Rig	Barque	Barquentine
Complement all told (souls)	46	28

It is stated the name of *Gauss* was given to the German vessel by the Emperor to emphasise the scientific character of her mission by associating it with the memory of the great authority on terrestrial magnetism.

The German vessel, although a little smaller than the *Discovery*, is intended to carry so much smaller a crew that she will probably prove to be no more crowded with her stores and equipment. Both vessels are strongly built of oak and sheathed in greenheart. The *Discovery*, like the *Fram*, has her frames in contact throughout her whole length, and the joints caulked so that even if all her triple skin of planking were stripped from her the vessel would still be watertight and seaworthy. She is of whaler pattern to the extent that her sides are not pierced by any openings, the only daylight for the cabins coming from deck-lights ; but the cabins, though dark and uninviting at the launch, are exceptionally roomy and well-planned, and when lighted by the electric light will be extremely comfortable. The *Gauss* is also to be furnished with the vital necessity of electric light, a boon that none but polar voyagers can fully appreciate, and she is, in addition, to have the luxury of steam-pipes for heating purposes throughout the whole inhabited part of the ship ; the *Discovery* will probably be heated by stoves.

Both vessels are provided with wells and gear for hoisting out both rudder and propeller, and a spare rudder will be carried which can be shipped securely and speedily if the original steering gear should be seriously damaged. The bows of both ships are heavily plated with steel to enable them to cut through or break comparatively thin ice ; but the form of the stem is different. Both have a great sheer, so that the vessel would tend to ride up on any floating ice she encountered and break it with her weight, but the stem of the British ship is a straight line forming an obtuse angle with the keel, while that of the German vessel is a convex curve. The sterns also differ, that of the British vessel having a much longer overhanging counter than the *Gauss*, so that her length over all is probably from 15 to 20 feet greater.

The details of laboratory accommodation can be more profitably described when the space is finally apportioned and the equipment in place ; but the magnetic observatory on the *Discovery* has been very carefully planned so that it shall be more than 30 feet from any iron or steel —even the bolts and nails in its vicinity are all of brass.

The living rooms in both vessels are amidships, the stokehold and engine-room being placed right aft, while the whole lower hold is utilised as a great coal-bunker along the length of the ship. The *Discovery* is rigged as a barque ; the rig of the *Gauss* is officially described as that of a "three masted schooner," but her published sail-plan shows the foremast completely square-rigged, the main and mizzen having only fore-and-aft sails, so that she is better called a barquentine. We believe that this rig, rendered necessary probably on account of the small crew carried, is not a usual one for polar ships. Machinery and masts are now being rapidly put in place, and the *Discovery* may be expected in the Thames to take her stores on board about the end of May or early in June.

MEETING OF THE INTERNATIONAL ASSOCIATION OF ACADEMIES.

THE business of the Paris meeting of the International Association of Academies was commenced on Tuesday morning, when the delegates assembled at the Institute. The delegates were received, on Saturday, by the president ; and the French Government, as well as the Municipal Authorities, have combined with the Institute to make the meeting a success by facilitating all the arrangements and providing lavish entertainment. By this official action, the dignity and importance of the meeting are declared, and the delegates are made to feel that they are welcome visitors.

Tuesday's meeting was devoted to preparatory business, and M. Darboux gave an address on the objects and work of the Association. The financial position was considered, and suggested additions and alterations of the rules were discussed. A committee was appointed to consider a scheme for the mutual loan of manuscripts. In the evening, the president of the Institute, Count de Franqueville, gave a reception to the delegates and their families at his residence, the Château de la Muette. Yesterday the arrangements included a visit to the Château of Chantilly, bequeathed to the Institute by the Duc d'Aumale. This afternoon there will be a reception by M. Émile Faguet at the French Academy, and in the evening a dinner will be given by the Institute. On Saturday afternoon a visit will be made to the National Library, under the direction of M. Léopold Delisle, and on Saturday evening the Municipal Council will give a dinner to the delegates and members of the Institute. The dinner will be followed by a reception and concert, to which the families of the guests are invited. On Sunday a special piece will be represented at the Comédie-Française in honour of the delegates.

From this programme it will be seen that the serious

[1] "La Tourbe et Les Tourbiéres, par Alb Larbalétrier. Encyclopédie cientifique des Aide Memoire." (Paris : Masson et Cie.)

work of the meeting will be relieved by congenial entertainment. The way in which the various authorities, as well as private individuals, are contributing to make matters run smoothly, and to ensure that the delegates shall remember their visit with pleasure, is a noteworthy characteristic of the arrangements.

NOTES.

IT appears that the Bement collection of minerals, which became the property of the American Museum of Natural History at the end of last year, was presented to the museum by Mr. J. Pierpont Morgan. The collection is estimated to be worth about 40,000*l.*, and was commenced by Mr. C. S. Bement, of Philadelphia, who began it thirty-five years ago and kept adding to it until it passed from his possession. Neither time nor money was spared in gathering desirable specimens, and in 1884 the Bement collection was looked upon as so important as to be made the subject of a special report in the interest of the National Museum, Washington. Mr. Morgan's public spirit and generosity have prevented the collection from being distributed or from leaving the United States. In addition to this gift, he has presented to the museum the Tiffany collection of gems. Mr. Morgan's earlier contributions to the museum, of which he is a trustee, have been on a munificent scale, but the recent gifts surpass previous ones in value and scientific interest. Referring to the gifts at a recent meeting of the Board of Trustees, Mr. A. S. Hewitt remarked :—"The trustees rejoice that the museum begins the new century with the acquisition of two very remarkable, if not unique, collections of minerals, which, added to the treasures already in its possession, raise its position among the museums of the world to the level occupied by the British Museum, heretofore, by common consent, regarded as rich beyond comparison in rare specimens.

WITH reference to the recent proposal to stock the London parks with butterflies, Prof. Meldola writes to say that the experiment, although worth trying, is not, in his opinion, likely to prove successful. The species which have been observed in the Metropolis are, with the exception, perhaps, of *Pieris rapae*, only casual visitors, for the most part imported and only occasionally immigrating spontaneously. It is very doubtful whether the species which it is proposed to introduce, viz. the *Vanessas*, would survive more than the first season, and if any should escape the London sparrow and hibernate it is more than probable that they would voluntarily migrate the following spring to fresher surroundings than could be offered by a vegetation which had gone through the ordeal of a London winter. Prof. Meldola adds that in the year 1871 he perfectly well remembers the leopard-moth, *Zeuzera aesculi*, being quite common on the tree-trunks in the London parks and squares. It was observed during that season that the ground at the foot of the trees was often littered with wings of the moth, as though some bird—probably the sparrow—had been at work among the insects. If the suggestion to stock the parks necessitated an annual renewal of the butterflies, it would be better to leave them in their native country haunts.

IT is stated that the Cunard Company contemplate utilising the Marconi wireless telegraph on their Atlantic steamers.

MR. C. E. BORCHGREVINK, the Antarctic explorer, has been created a Knight of the Order of St. Olaf by King Oscar.

MR. J. WILSON, U.S. Secretary of Agriculture, has arranged to carry into effect, on July 1, the reorganisation of certain of the divisions of the Department of Agriculture, as provided by the last Congress. It may be remembered that, in addition to the Weather Bureau and the Bureau of Animal Industry, four new bureaus were created, namely, those of Plant Industry, of Forestry, of Chemistry and of Soils.

WE learn from *Science* that an influential committee has been formed in Italy to celebrate the fortieth anniversary of Prof. Paul Mantegazza's entrance on his career as a teacher. This event will be celebrated at Florence on April 30, and at the same time as the thirtieth anniversary of the Italian Society of Anthropology. It is proposed to collect a sum of money to be used for the endowment of the new laboratory of anthropometry which Prof. Mantegazza has established at Florence.

THE Rome correspondent of the *Times* records the opening, by Lord Currie, of the British Archæological School in Rome. More than one hundred representatives of international archæology gathered at the Palazzo Odescalchi, where the school is situated, the Italian Government being represented by Commendatore Fiorilli, Director-General of Antiquities and Fine Arts, the Academia dei Lincei by several members, the German Archæological Institute by Profs. Petersen and Hülsen, and the French École de Rome by Mgr. Duchesne.

SEVERAL papers on scientific aspects of alcoholism were read at the International Temperance Congress held at Vienna last week. Among the subjects described and discussed were the effect of small fixed quantities of alcohol on the speed and quality of certain simple and calculable mental operations, such as sums in addition, and committing figures to memory ; the poisonous effects of alcohol in certain nervous affections ; the effect upon the power of resistance to disease ; remedial measures ; and reforms recently introduced into the French Army for the repression of alcoholism.

IT has been decided (says the *Victorian Naturalist*) that the National Fund raised in memory of the late Baron von Mueller, Government Botanist of Victoria, shall be devoted to the institution of a medal and prize to be awarded at intervals of not less than two years to the author of the most important contribution to natural knowledge which shall have been published in the British dominions not more than five years, or less than one year, prior to the date of the award, preference being given to work having special reference to Australasia. It is proposed that the Mueller Medal shall be awarded by a committee of the Australasian Association for the Advancement of Science appointed for the purpose every two years.

FROM the *Victorian Naturalist* we understand that Prof. Spencer, F.R.S., of the Melbourne University, and Mr. F. J. Gillen, of South Australia, will start from Oodnadatta, the present terminus of the transcontinental railway, nearly 700 miles north of Adelaide, on their expedition for the purpose of studying the habits and customs of the aboriginals of the northern portion of Central Australia, about the middle of the present month. The start has been somewhat delayed owing to the drought which has existed for some time in the portion of the continent to be visited. It is also proposed to cross into Queensland and continue Dr. Roth's ethnological work, and afterwards to traverse some of the larger rivers of the Northern Territory, and if time permit, to visit the Wyndham district on Cambridge Gulf in North-West Australia.

A COMMITTEE, to be known as the Lightning Research Committee, has been organised by the Royal Institute of British Architects and the Surveyors' Institution, with the object of collecting and tabulating information from all parts of the country as to damage resulting to buildings from lightning. The committee includes Mr. John Slater (chairman), Major-General E. R. Festing, C.B., F.R.S., Dr. Oliver Lodge, F.R.S., Messrs. J. Gavey, W. P. Goulding, W. N. Shaw, F.R.S., H. H. Statham, A. R. Stenning, Arthur Vernon, Killingworth Hedges, C.E. (hon. secretary). In pursuance of their inquiry the committee seek the co-operation of competent observers in all parts of the country, with a view to obtaining accurate

details, noted on the spot, of the effect of lightning-strokes on buildings, whether fitted with conductors or not. Persons willing to assist by their observations are invited to communicate with the secretary at the offices of the Royal Institute of British Architects, 9 Conduit Street, London, W.

WE learn from the *British Medical Journal* that in the course of the present year a statue of Pasteur is to be erected in the town of Dôle, in the Jura Department, which was his birthplace. The statue, which is from the chisel of M. Antonin Carlès, is in bronze, and stands on a conical pedestal 8 metres high. Pasteur is represented as standing in an attitude of meditation. At the base of the monument is a group representing Humanity holding out two children to Pasteur, whilst Science offers him a palm.

THE death is announced in the *Times*, at the age of ninety-three years, of Prof. Paul Chaix, a well-known citizen of Geneva and a geographer of distinction. In 1836 he was appointed master of geography and history in the Industrial College of Geneva, and in 1868 he became professor at the Gymnasium, and a few years later at the University. M. Chaix was an active member of the German Geographical Society, and an honorary corresponding member of the Royal Geographical Society. He was the author of a map of Savoy, a history of Central America, various elementary geographical works, and papers to geographical and other journals.

THE Paris correspondent of the *Chemist and Druggist* announces the death, at Grenoble, of Prof. F. M. Raoult, an eminent chemist and senior of the Faculty of Sciences of that town. He was a corresponding member of the Paris Academy of Sciences, a foreign member of the Chemical Society, London, and of the Imperial Academy of St. Petersburg, and a Commander of the Legion of Honour. M. Raoult was 71 years of age, and held a high place amongst French chemists. The death is also announced of M. Maxime Cornu, a well-known French botanist, who took a leading part in the endeavours to eradicate phylloxera in France. The deceased was a professor at the Paris Museum of Natural History, and contributed largely to the literature of botany.

IT is a matter for congratulation that serious efforts are being made by the municipal authorities in many civilised countries to combat disease by all means available for that purpose. We therefore welcome the news that an excellent institution for the exclusive treatment of patients suffering from the various forms of cancer—either curable or incurable—is being built in Moscow at the expense, which is said to be an enormous one, of the municipality of that city. It is understood, however, that the main object of erecting this special hospital is to provide the necessary means of studying the nature of cancer from every possible point of view and of enabling and encouraging more thorough pathological and clinical research to be carried out in connection with that malady. Accordingly, we may reasonably hope that by carefully conducted scientific investigations the light of knowledge will be thrown upon a scourge which has, of late years, and particularly in the northern regions of the Russian Empire, assumed a most formidable extent and character. It may be added that the new institute will be under the entire management of a committee consisting of several members of the medical faculty, with Dr. Lewschin, professor of surgery in the University of Moscow, as its director. In addition, facilities will be offered to students who, desirous of joining the scientific circle of investigators there, have already proved themselves efficient workers in that department of pathological research.

THE very alarming reports which were published by the German Press towards the end of March concerning both the extent and rapidity with which the recent outbreak of an epidemic of enteric fever in Upper Silesia had spread throughout that country, and particularly the serious complications and the high rate of mortality by which it was followed, have prompted the Prussian "Cultusminister" to request Prof. Robert Koch to proceed at once to that part of the German Empire for the purpose of ascertaining the original source of the infection and of adopting some trustworthy measures to check its further present spread, and to prevent, as far as possible, its occurrence in the future. Prof. Koch, it is reported, will now leave Berlin for Beuthen, which is situated near the Polish frontier, where he will, in the first instance, examine the so-called "hygienic station," which was erected there for bacteriological purposes some years ago, whence he will proceed to the other more important places and towns of Silesia with a view to inspecting carefully their present sanitary conditions. It is believed that Prof. Koch will be engaged on his mission for from six weeks to two months; subsequently his report, which, it is understood, will cover all the main points of his bacteriological investigations bearing upon enteric fever, will be published by the Reichsgesundheitsamt of Berlin.

REPRESENTATIVES of several societies interested in archæology met Sir Edmund Antrobus on Friday last at Stonehenge to discuss the details of the resolutions passed at the recent conference in London, and referred to in our last issue (p. 576). The *Times* reports that all the details of the work it is proposed to do with the view of maintaining the stones in a position of safety were fully discussed, and the representatives present unanimously approved all the suggestions made at the London conference. It was decided to proceed with the work as soon as the weather is favourable. It will be carried out under the supervision of Mr. Delmar Blow, assisted by an eminent civil engineer; and nothing in the way of restoration will be attempted. The only object the societies have in view is the preservation of this ancient memorial. The first work to be undertaken will be the raising of the huge monolith, which overhangs the altar stone and is in a most dangerous condition, into an upright position. It is the largest and finest monolith in England next to Cleopatra's Needle. At present it rests on a smaller stone, but there are two large flaws or cracks in it, and if it were to fall it is feared that it would be broken into three parts. The experts engaged in the work will next proceed to examine the stones numbered 6 and 7 on Mr. Petrie's plan, with the view of putting them in a position to support the lintel which rests upon them. The other recommendations of the societies will be carried out in due course; and, in the meantime, Sir E. Antrobus hopes to obtain permission to divert the roadway now passing through the earth-circle which surrounds the stones, and to proceed with the erection of the wire fence approved by the conference.

M. DE FONVIELLE, ex-president of the French Society for Aërial Navigation, delivered an address upon the position and progress of aëronautics in France, at a meeting of the Aëronautical Society held at the Society of Arts on Monday. In the course of the address, M. de Fonvielle referred to several important matters requiring the consideration of meteorologists, astronomers and others interested in scientific ballooning. One refers to the time at which the balloon ascents are made in connection with the International Aëronautical Committee. The balloons are sent up about eight o'clock in the morning, but M. de Fonvielle urged that a better plan would be to let the ascents be made at night, when less disturbing variations of temperature would be experienced. As manned balloons are sent up at the same time as free balloons, it was suggested that by making the ascents at night opportunity would be afforded of making astronomical observations which might be prevented at low levels by cloudiness. Another point which M.

de Fonvielle mentioned was that the ascents should not be made upon a particular day of the calendar month, as they are at present, but in the lunar month, by preference near the time of New Moon. The interference of moonlight with intended astronomical observations would thus be obviated.

Dr. Hergesell, president of the International Aëronautical Committee, has sent us an account of the preliminary results of the international balloon ascents of March 7. Twelve unmanned balloons, three manned balloons and one kite were sent up from various places on the Continent, but the records of three of the unmanned balloons were lost. At Vienna a height of 10,000 metres was reached; the lowest temperature recorded was −62° C. At Moscow the temperatures recorded were −13° C. at starting, −20° at 4400 metres, and −41°·6 at 6650 metres. At Trappes, near Paris, one balloon reached 10,820 metres and recorded −43°; the minimum temperature, −51°·2, was registered at 8792 metres. A second balloon registered −43°·6 at 10,481 metres and −53° at 8891 metres. At Strassburg a height of 10,000 metres was reached, and the minimum temperature recorded was −52°. Perhaps the most noteworthy record is that of a second balloon from Moscow, −12° at starting, −15° at 2700 metres; an inversion of temperature, +2°, occurred at an altitude of 250 metres.

The *Scientific American* states that there is a project on foot for the construction of a movable electric platform on the right bank of the Seine. The platform will be underground, and its length will be about six miles. The route proposed passes under the Avenue de l'Opera, the great boulevards, Boulevard Sebastopol, the Rue Turbigo and the Rue de Rivoli. The new scheme calls for four platforms instead of three, as was in use at the Paris Exposition. The first platform will be stationary, the second will have a velocity of 1½ metres a second, the third 3 metres, and the fourth 5 metres. This will enable pedestrians to have a very rapid means of transit afoot in a portion of Paris which is greatly encumbered by vehicular traffic, for, as all the locomotion is in one direction, persons can walk very fast on the fourth platform, and will be able to cover a great distance. Some means of transit on the streets mentioned is so necessary that it is probable the scheme will be carried into effect.

There have been some discrepancies in recent allusions to the 1885 experiments carried out at Paris with the navigable balloon *La France*, Mr. Chanute, in the *Engineering Magazine*, April 1896, referring to speeds of 14 miles an hour, while Sir Hiram Maxim, in the *Aeronautical Journal*, October 1900, spoke of the speed as about 4 miles an hour, and only a single case of return to the point of departure. A note on this subject appears in the *Aeronautical Journal* for April, from which it appears that the balloon returned five times to its starting point. On referring to the original article in the *Comptes rendus* for 1886, we gather that the speed was estimated at from 4 to 6 metres per second, and probably the discrepancy was due to some confusion in regard to the units.

The Botanical Exchange Club of the British Isles has just issued its annual report for 1899, from which we gather that the number of plants sent in shows a considerable falling off from the average of recent years. It is to be feared that the rival attractions of golf, photography and philately have diverted the attention of many who in former days devoted their spare time to the study of the British flora, and that modern facilities for attending science classes have hardly succeeded in maintaining the interest in field botany and natural history that was shown formerly. Still the report contains many records of interest, notably of the specific and varietal forms of the difficult genus Rubus, which have been studied by the Rev. W. Moyle Rogers, while Mr. F. Townsend has commented on the forms of Euphrasia. The distributor (Rev. W. R. Linton) calls attention to the desirability of members sending not less than ten specimens of each plant, but we question whether a too literal interpretation of this recommendation might not lead to the total uprooting of certain rarities.

Although it has long been known that no actual gas obeys Boyle's law, attention has been chiefly centred round the divergencies which occur at high pressures. It is true that the behaviour of gases at low pressures has received attention from Siljeström, van der Ven, Mendeléeff, Amagat, Fuchs, Krajewitsch, Baly and Ramsay and McLeod, and these experiments have led to the discovery of a discontinuity in the case of oxygen, but the experimental difficulties have led to considerable divergencies of results in other respects. An investigation is now described by Prof. A. Battelli in the *Nuovo Cimento* for January and February, which leads to the following results:—(1) Hydrogen obeys Boyle's law for pressures below one atmosphere down to about 0·2 mm.; (2) Air deviates slightly from the law between 2 and 5 mm.; (3) Oxygen exhibits a discontinuity about 0·7 mm.; (4) Carbonic anhydride at low pressures is compressed more than Boyle's law would indicate, probably owing to absorption by the walls of the containing vessel. With the exception of oxygen, and consequently air, the present investigation does not bring to light any anomalies not attributable to experimental conditions. On the other hand, the existence of discrepancies, representable by the introduction of a discontinuous function into the characteristic equation, is not incompatible with the kinetic theory, but may be attributable to changes in the grouping of the molecules.

The Accumulator Industries Co. Ltd., has brought out a new primary cell, under the name of the "Cupron-Element," in which the electrodes are plates of zinc and copper oxide and the electrolyte caustic soda, or, for special purposes, caustic potash. The E.M.F. of this combination is low, amounting to only about 0·85 volt; but this is compensated for by a low internal resistance. It is claimed that the difficulties hitherto met with in the manufacture of a suitable anode (copper oxide) plate have been overcome, and that a coherent and, at the same time, highly porous plate has been obtained which can easily be regenerated when exhausted by simple exposure to the air. The cell has the advantage that there is no local action when on open circuit. To judge from the discharge curves printed in the catalogue, the cell has a high capacity and is capable of giving continuously a steady current. Of course, a primary battery with zinc as the ultimate source of energy can never be really a cheap way of getting current; but one which gives little trouble, is easily recharged and gives a good steady current, has a considerable range of utility, especially as a means of charging small accumulators.

To the March number of the *American Naturalist* Dr. W. H. Dall contributes an account of the morphology of the hinge-teeth of bivalve molluscs, in which the various systems of nomenclature for these structures that have been from time to time proposed are discussed and contrasted. Many problems in connection with the homology and evolution of these structures still await solution.

In another paper in the *American Naturalist* for March Messrs. Wheeler and Long discuss the males of certain species of ants of the genus Eciton, with figures of several. These ants have the habit of seizing the larvæ and pupæ of other kinds of ants, as well as insects of other descriptions, and storing them up in their nests to serve for food as occasion requires. When the colony removes to another nest the booty is carried with the other *impedimenta*. And if Eciton ants be fed with termites

or the larvæ of other species, many of these termites or larvæ will be carried about or stowed away in some corner of the nest for several days before being consumed.

WE are glad to learn, from its Report for the year 1900, that the Rugby School Natural History Society is in a flourishing condition and continues to make good progress. The requirements of its members render it essential that this body should not confine its investigations and its museum to local subjects, but it may be questioned whether a collection of Samoan ferns is entitled to form one of its exhibits. Two of the members of the Society are endeavouring to emulate Mr. Kearton in photographing the nests of birds in their natural situations, and, judging from the specimens published, may be congratulated on their efforts.

THE twentieth fasciculus of "Papers from the Harriman Alaska Expedition," now in course of publication in the *Proceedings* of the Washington Academy, deals with the nemertean worms, and is illustrated by an excellent coloured plate. During the summer of 1899 exceptionally favourable opportunities were enjoyed of collecting these worms on the Alaska coast south of Bering Sea, and the result has been to add very largely indeed to our knowledge of these organisms. Some thirty-two species were collected by the expedition, of which Dr. W. R. Coe describes no less than twenty-seven as previously unknown to science, while only two of the remainder had hitherto been recorded as denizens of the Pacific. No new generic types were found. For preserving these worms Dr. Coe reports that he found a solution of from two to five per cent. of formalin in sea-water gave satisfactory results so far as the preservation of external form is concerned, although it ruined the nerve and connective tissues.

IN the *Proceedings* of the Washington Academy of March 26 (vol. iii. pp. 111–138), Mr. G. S. Miller describes a collection of mammals made by Dr. W. L. Abbott in the Natuna Islands, lying between the Malay Peninsula and Borneo. Two collections of mammals from these islands have been previously described, the one by Messrs. Thomas and Hartert and the second by Mr. Thomas alone, the material having been obtained by Mr. A. Everett in 1893 and by Mr. E. Hose in the following year. The well-known energy of Dr. Abbott has added largely to the number of species obtained by these collectors, and Mr. Miller describes many of the acquisitions as new, among them being two species of chevrotain and a wild pig. With regard to a discussion that has taken place as to the relationships of the Natuna fauna, the present collection tends to show that there is a greater similarity between the mammals of the Malay Peninsula, Borneo and the intervening islands than has been hitherto supposed. Consequently there is little room for discussion as to whether the Natuna fauna comes nearer to that of the peninsula or of the large island.

IN its Report for the past year the Wellington College Natural Science Society directs attention to the efforts it has been making towards the revival of field work by the establishment of a field-club for the systematic investigation of the local fauna and flora within a twelve-mile radius. The project is worthy of all commendation as being the one important *raison d'être* of local natural history societies. And a special interest and importance attaches to such an investigation at the present time in the neighbourhood of the College. Six years ago the Society published local faunal lists compiled from the records of the previous twenty years. "During that time a great change came over the country just round the College; cultivation, drainage and building have all aided in destroying many plants and insects that used occasionally to be found; and these lists, although interesting as bearing record as to what did occur at one time or another, are now necessarily incomplete; many of the finds are no longer to be found, whilst other and new ones have to be added." It is much to be desired that investigations of a similar nature should be undertaken in other parts of the country where analogous changes have taken place.

PART 4 of vol. xiii. (March 1901) of the *Proceedings* of the Cotteswold Naturalists' Field Club contains an elaborate and well-illustrated memoir by Dr. S. S. Buckman on "homœomorphy" among Jurassic brachiopods. By homœomorphy the author understand "the phenomenon of species nearly alike so far as superficial appearance is concerned, but unlike when particular structural details are closely examined. It is the phenomenon of similarity in general with dissimilarity in details." Dr. Buckman's views are too complicated to discuss in this column, but it may be mentioned that, in his opinion, much confusion has arisen in the description of Jurassic brachiopods owing to failure in recognising the phenomenon in question. To the same publication the Rev. A. R. Winnington-Ingram contributes some notes on polydactylism in cats. The family to which he refers have a cross of the Manx breed, and the supernumerary digits are attributed to reversion to polydactylous ancestors intermediate between fishes and amphibians.

THE way in which the American Anthropological Museums are growing is a continual source of congratulation and at the same time of envy on our part and regret that there is such indifference to the science in Britain. To give one instance of the example set by our American friends, Dr. G. A. Dorsey informs us in *Science* (n. s., vol. xiii. p. 219) that in 1897 the Hopi collection of the Field Columbian Museum for Chicago was comprised within three cases. Thanks to Dr. Dorsey's representations, Mr. Stanley McCormick was induced to purchase for the Museum a very extensive collection formed by Mr. H. R. Voth, who has long been a missionary among the Hopi. Then, in order to render the exhibit exhaustive, Mr. McCormick, with characteristic American generosity, provided the funds for four expeditions which have very successfully investigated the archæology of the Hopi country, with the result that two halls in the Museum containing thirty-four cases are devoted to a demonstration of the ordinary everyday life of the Hopi and their past culture, and a third hall will shortly be filled. The most valuable exhibits are reproductions of nine of the underground altars, with their sand mosaics, which play so important a part in the great nine-day ceremonies of these interesting people. We have nothing in the whole British Empire to compare with this!

DR. THORODDSEN contributes to *Petermann's Mitteilungen* a paper on the earthquakes which occurred in Iceland in August and September 1896. In order to collect material for this report the author first addressed inquiries to a number of residents in the district affected—the southern lowland of Iceland—and in 1897 made an examination on the spot. Dr. Thoroddsen has been able to locate with considerable precision the region of greatest intensity of disturbance, and finds that, as in former cases, the chief centre of origin lay near the boundary between the subsiding lowland and the surrounding highland. The disturbance was, therefore, of tectonic origin; the volcanoes in the neighbourhood—Hekla, Katla and Eyjafjallajökull—remained passive during and after the earthquake shocks.

THE *Geographical Journal* for April contains an analysis of the physical geography of South America, by Col. G. E. Church. The paper, which is to form the introductory chapter of a book on the subject, gives a close comparison of the conditions in North and South America, and shows that "in general, man finds himself confronted by severe conditions in his struggle with

nature in South America. Thus far his efforts to develop and utilise its vast resources have made its commercial history an epic. The thought naturally presents itself that had North America fallen to the lot of the Latin race in the European occupation of the New World, and South America to the Anglo-Saxon, the former might still have maintained its old premacy; for the more rapid progress of the latter may not be due so much to racial superiority as to advantageous geographical urroundings."

The list of additions to the library of the Royal Gardens, Kew, received during last year, occupies eighty-three pages in the *Kew Bulletin* (Appendix ii. 1901) just issued. The titles are printed on one side of the page only, so as to allow the list to be cut up and the slips used by persons and institutions having catalogues based on the Kew catalogue.

Announcement has just been made by a committee of American anthropologists, of which Mr. F. W. Hodge, managing editor of the *American Anthropologist*, is secretary, of the proposed publication of an illustrated volume containing more than hirty folk-tales which were collected and translated by the late Frank Hamilton Cushing during his long and intimate association with the Zuñi Indian tribe of New Mexico. Information and subscription forms may be obtained from the secretary, whose address is Washington, D.C., U.S.A.

The third divisional volume has been received of Thompson's "Gardener's Assistant," a new edition of which, edited by Mr. William Watson, assistant curator at the Royal Gardens, Kew, is in course of publication by the Gresham Publishing Company. Among the subjects dealt with are popular garden plants, greenhouse and conservatory, greenhouse plants, stove plants, orchids, indoor and hardy ferns, succulent plants, hardy shrubs, bedding and floral decorations. Several plates and numerous excellent illustrations accompany the descriptive text.

A large terrestrial globe is an essential piece of furniture for the satisfactory teaching of geography. The ideal globe is in relief, but the price at which such a globe can be well produced s prohibitive to its extensive use. A large globe in which physical features are given prominence is the next best substitute, and this has been produced by Messrs. Philip and Son under the title of "Philip's Physical School Globe." The diameter is nineteen inches, and three forms of mounting of the globe are constructed, namely, one a pedestal for table, another the same with the addition of a graduated half meridian, and the third a tripod stand, with complete meridian and horizon.

The following prices obtained for some of the natural history books from the library of the late Mr. P. Crowley, sold by Mr. J. C. Stevens at his auction rooms on Monday, are of interest:—"Transactions of the Entomological Society," complete set, 46 vols., 38*l.*; "Catalogue of the Birds in the British Museum," vols. 1 to 27, 1874–95, 48*l.*; "The Ibis," 1859 to 1900, with indexes, 42 vols., 75*l.*; "Proceedings of the Zoological Society," 1830 to 1900, 60 vols., 60*l.*; "The Birds of the British Islands," by Lord Lilford, 7 vols., 63*l.*; "Biologia Centrali Americana," 35 vols., 90*l.*; "Birds of Europe," by H. E. Dresser, vols 1 to 8, 1871–1881, vol. 9 supplement, 1895–6, 56*l.*; "Histoire Physique, Naturelle et Politique de Madagascar," by A. Grandidier, 1875–95, 35*l.*; "The Birds of Asia," by John Gould, 7 vols., 1850–1883, 51*l.*; "The Birds of New Guinea, Papuan Islands and Australia," by J. Gould, 5 vols., 1875–78, 45*l.*; "The Birds of Great Britain," by John Gould, 5 vols., 1863, 49*l.*; "Monograph of the Pheasants," by D. G. Elliot, 2 vols., 1872, 53*l.*; "Rough Notes on the Birds observed during Twenty-five Years' Shooting and Collecting in the British Islands," by E. T. Booth, 3 vols., 1881–7, 25*l.*

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. C. L. Lane; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Miss Leah Simmons; a Rufous-necked Scimitar Babbler (*Pomatorhinus ruficollis*), a Golden-backed Woodpecker (*Brachypternus aurantius*) from India, presented by Mr. E. W. Harper; an Indian Python (*Python molurus*) from India, presented by Mr. C. Oscar Gridley; a Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Mr. C. King; ten Indian Cobras (*Naia tripudians*) from India, ten Reeve's Terrapins (*Damonia reevesi*) from China, ten Roofed Terrapins (*Kachuga tectum*) from British India, ten Blue Lizards (*Gerrhonotus coeruleus*), six Red Newts (*Sperlepes rubra*) from North America, a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, deposited; an English Wild Cow (*Bos taurus*), a Bactrian Camel (*Camelus bactrianus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Nova Persei.—*Bulletin* No. 16 of the Yerkes Observatory contains a report from Prof. Hale on the work done in connection with the new star in Perseus. An examination of the Nova with the 40-inch refractor on February 24 failed to show any trace of nebulosity. Photographs of the spectrum were obtained on eight nights, using Erythro plates, with spectrographs of one and three prisms respectively. These extend from H_a in the red to the ultra-violet H_i; comparison spectra were taken of titanium, hydrogen and sodium. Photographs of the region of the Nova have been obtained with the 40-inch telescope, and will be subsequently measured at Columbia College Observatory. The brightness of the star has been measured by the wedge photometer.

A Remarkable Group of Nebulous Spots.—Prof. Max Wolf, of Heidelberg, writes to the *Astronomische Nachrichten* (Bd. 155, No. 3704), describing an appearance of small nebulous bodies surrounding the star

$$\left.\begin{array}{l}\text{R.A.} = \ 12^{\text{h}}\ 52^{\text{m}}{\cdot}6 \\ \text{Decl.} = +\ 28^\circ\ 42'\end{array}\right\}(1855{\cdot}0).$$

They are so close together as to form a remarkable feature in the field of view. He was able to count 108 in a circle about 30′ of arc in diameter. Some of the fourth or fifth magnitude showed a central condensation, more or less elongated, while other fainter ones had a roundish form.

Stonyhurst College Observatory.—The annual summary of the meteorological, magnetical and other observations made at the Stonyhurst Observatory in Lancashire has just been issued by the director, Father Sidgreaves. Special co-operation with the International Meteorological Committee has been in force since November, observations of clouds and wind being made throughout three successive days of each month; on the second of these days balloon ascents are made by representatives of the Committee.

The work of comparison between individual sun-spots and terrestrial magnetic storms has been concluded and published in the *Memoirs* of the Royal Astronomical Society. This covers the period of eighteen years from January 1881 to December 1898.

Experiments are in progress in connection with the improvement of the present means of obtaining stellar spectra, quartz lenses being now employed, so that more of the ultra-violet region will be photographed.

Catalogue of Double Stars.—Vol. i. of the *Publications* of the Yerkes Observatory consists of a general catalogue of 1290 double stars, discovered from 1871–1899 by Prof. S. W. Burnham. The stars are arranged in order of their right ascensions, full particulars being given of all the micrometrical measures of each pair. The work has been done with telescopes varying from 6 inches to 40 inches in aperture, the greater number (451) of the discoveries having been made with the smallest instrument.

INDIAN FORESTRY.[1]

BEFORE retiring from the Indian Forest Service the author obtained the sanction of Government to the publication of this volume, which contains a brief description of the forests and a sketch of the introduction and growth of forestry in the British Indian Empire. In the preface he says: "My career in the Indian Forest Service has extended over thirty-three years, and though I was not in the country when regular forest conservancy was first introduced, I arrived when it was still quite a small sapling, and I have seen it grow to the mighty tree it is at present, under the wide-spreading shadow of which I have grown old."

Mr. Ribbentrop is one of the two young German forest officers whom the writer of these lines in 1866 was permitted to engage for the Indian Forest Service. He came from Hanover, where he had received his professional training, and had worked under the late Forst-director Burckhardt, one of the most eminent foresters of his day in Germany. The other was Dr. W. Schlich, now principal professor of forestry at Coopers Hill, whose excellent "Manual of Forestry" has repeatedly been discussed in these columns.[2]

Obviously it is out of the question, within the space here available, to follow the author through his description of the forests and through his account of the earlier stages of forest administration in India; it must suffice, briefly, to state a few of the principal results accomplished and to indicate the lines on which, in the interest of the 294 millions inhabiting the large British Indian Empire, further progress in this business ought to be made. As it will be satisfactory to deal with the last figures available, those for 1898–99 will, in a few cases, be quoted, the book giving only those to the end of 1897–98.

In 1899 the area of reserved Government forests in the different British provinces of India aggregated 84,148 square miles, or 54,000,000 acres, more than the total area of England and Ireland together. The State forests of the German Empire only aggregate 16,400 square miles. These are very large figures, but the British Indian Empire is a very large country. Of the total area of the German Empire the State forests occupy 8 and in the British provinces of India the Government reserved forests occupy 8·6 per cent. of the total area. At first sight this seems a most satisfactory result; the Indian State forests constitute a slightly higher percentage than those of the German Empire, a country where the necessity of good forest management is acknowledged to the fullest extent. Besides the 16,400 square miles of State forests, however, there are large areas of Crown forests, of forests belonging to public corporations, there are, further, 8400 square miles of communal and 26,000 square miles of private forests. All these, excepting a small proportion of the private forests, are managed as efficiently as the State forests. The Governments in the different States have shown the way, they have taken the lead in the management of their forest domains, and the other proprietors have gradually followed suit. The total forest area of the German Empire amounts to 54,000 square miles, or 26 per cent. of the entire area. Sixty years ago Germany was an important timber exporting country, since then, as a necessary consequence of the development of industries and manufactures, and the increase of wealth, the imports have gradually exceeded the exports. Now it is only second to Great Britain in the list of timber importing countries, and this is so, although the annual production of wood per annum is increasing steadily, as the result of the great progress made in forest management. The total annual production of timber and firewood of the German forests is estimated at 38,000,000 tons, and this is supplemented by an import of 4,600,000 tons. The material progress of the country would not be possible had it not the large home production to fall back upon. There are other forest lands in India which are nominally under the control of the Forest Department, viz. 8800 square miles of protected and 27,700 square miles of unclassed forests, but in these areas protection is nominal, and they are not managed with a view to a sustained yield. The reserved forests are the only trustworthy resource for the future, and these, as stated, only form 8·6 per cent. of the total area. One of the excellent maps appended to the book illustrates the distribution of these forests in the different parts of the Empire, and this map shows at a glance the very unequal distribution. Berar has 23, the Central Provinces have 22, Burma has 9, but the North-West Provinces and Oudh have only 3·6 and the Punjab only 2 per cent. of Government reserved forests.

Nevertheless, it is an important point gained that so large an area is at the disposal of Government and that it is managed, so far as circumstances permit, with the view of obtaining from it a sustained and, if possible, steadily increasing yield of timber and other forest produce. The reader will ask the question whether it is right to lock up so large an area and to prevent the extension of cultivation, the establishment of fields within that area, in a country the population of which is mainly agricultural and is increasing steadily, which, indeed, is increasing with alarming rapidity in some districts and provinces.

What, then, has been the object in constituting this large area of reserved forest, and what is the object in maintaining it under forest? The author holds that the old records of Indian history, down to the invasion of the Punjab by Alexander the Great, prove that in those days extensive forests existed, and that the wholesale destruction of these forests has had the most deteriorating effect on the climate. He does not go so far as to maintain that by afforestation of large tracts the climate might be improved to such an extent as to stop the recurrence of these terrible seasons of drought, which are one of the chief difficulties with which the Government of India has to deal. It is evident, however, that his thoughts run in this direction. Doubtless it is not safe to lay stress upon such arguments. We may readily assent to the words of the author: "In a warm climate the denudation of a country diminishes its moisture and consequently its fertility" without indulging in the hope that in seasons of drought the presence of forests will increase the rainfall.

The local influence, however, of well-stocked forests in India no intelligent person, who knows the country, will deny. Well-stocked forests afford shelter to fields, to man and beast against the scorching winds of the hot season, and the dew is heavier in their vicinity. Of much greater importance still is the effect of well-stocked forests in regulating the surface drainage, in maintaining an even water supply in springs and streams, in preventing the denudation of hillsides, the silting up of rivers, and the destruction of fields and gardens in the plains by the sand and silt washed down from the hills. The author quotes a description of the Ratnagiri district on the western coast of the Peninsula, south of Bombay:—"Under a rainfall between 100 and 150 inches a year, this district is almost bare to the crest of the ghats, the result of fires, grazing and shifting cultivation. The four principal streams, which, rising in the Ghat Mountains, run a short course to the sea, were all navigable formerly, and were important for the trade of the country. Small boats still run, but the streams are gradually silting up, because the hills at their headwaters have become denuded."

In the Hoshiarpur district of the Punjab the Siwalik range of hills stretches from the Bias to the Sutlej river in a south-easterly direction. These hills consist of a very soft friable sandstone, alternating with strata of loam and clay. Formerly these hills were fairly well wooded. In 1846 they became British territory; the consequence was a rapid increase of population, a great demand for wood and charcoal in the fertile plains below, and the influx of a floating population of graziers with large herds of cattle. The result was complete denudation of these hills; the loose soil, no longer protected by vegetation, was washed down, broad rivers of sand spread into the plains below, and the end has been that fields and gardens of 940 villages, once prosperous, are now covered with sand, which has laid waste upwards of 70,000 acres of fertile lands. This district, rich formerly, is now traversed by numerous broad parallel sandy belts, cut out of the fertile and crop-bearing area.

Efficient protection of the reserved forests was only commenced a comparatively short time ago, and yet the author is able to state numerous instances from different parts of the country, in which protection has completely changed the character of the torrents and streams taking their rise in the forests. After rain, the water no longer rushes down, carrying sand and silt with it; the channels have been confined into permanent beds; they have become narrower and deeper, and the old beds to the edge of the channel have become stocked with grass and thousands of seedlings. The regulation of the underground waterflow takes more time, but Mr. Ribbentrop is able to report a case where, near a protected reserve in Ajmere, water is now found at the depth of 15 feet, where formerly it was not

[1] "Forestry in British India." By Berthold Ribbentrop, C.I.E., late Inspector-General of Forests to the Government of India. Pp. ii + 245, with 4 maps. (Calcutta: Office of the Superintendent of Government Printing, India, 1900). Price 4*s*. 6*d*.

[2] NATURE, vol. xli. p. 121; vol. xliv. p. 265; vol. liii. pp. 510, 535.

reached under 25 feet. The denser vegetation, which is the result of efficient protection, has everywhere counteracted erosion, has prevented landslips and sudden floods.

These indirect advantages of forest conservancy are obvious and of very great importance, but in most cases the chief object aimed at has been the production of timber, bamboos, firewood and other forest produce. The produce yielded by the forests furnishes the revenue, which enables Government to maintain a proper management of these estates. In old times the requirements in wood and timber of the people and of Government were met without difficulty. But with the increase of population, the growing wealth of the people, the construction of railways and other public works, the demands upon the forests increased. Within reach of the railways and elsewhere, forests disappeared with incredible rapidity. The threatening scarcity of timber and wood compelled the Government to take action. The author gives an interesting account of the efforts made in the beginning of last century on the western coast to provide a permanent supply of teak timber for ship-building, efforts which failed completely, because most injudicious and unjust attempts were made to interfere with private property. In the same way the history of the Tenasserim forests is told, the conservancy of which was urged by Dr. Wallich in 1827, and which were gradually, but effectively, destroyed through a series of mistaken measures. In the adjoining province of Pegu, at the command of Lord Dalhousie, and under the guidance of Sir Arthur, then Major, Phayre, in 1856, a systematic management of the teak forests was introduced, ensuring the certainty of a permanently sustained yield of teak timber, while the friendly co-operation in the business of the Karen and Burmese inhabitants of the forests was secured, by giving them profitable and permanent employment in forest work. When, after five years of hard work, a steadily increasing surplus revenue from the forests had been realised, proving beyond question the great value of those domains, the timber merchants of Rangoon, naturally anxious to get this valuable property into their hands, had prevailed upon the Government of India to grant their request, and accordingly in February 1861, orders were issued to the Commissioner of Pegu to throw open the forests to private enterprise. These orders, which were praised as most enlightened and liberal by Anglo-Indian public opinion, seemed at the time to put a stop to all progress in this direction. Fortunately, at a later date, the greed of the permit-holders under the new arrangements, resulted in breaches on a large scale of the terms of their permits, the consequence of which was, that the permits were cancelled.

Not more steady was the progress made in other provinces in attempting to place the management of the forests in such a position as to enable them to furnish the needful sustained yield of wood and timber. When Sir John (afterwards Lord) Lawrence landed at Calcutta in January, 1864, as Governor-General, he had determined to stamp out this new-fangled scheme of forest administration, which would weaken the position of the chief civil district officer by taking away from him the charge of the forests. It was only through the fortunate accident that Sir Richard Strachey, at the time secretary to the Government of India in the Public Works Department, who had some time previous taken charge of the forest business, gradually gained influence over the Governor-General to such an extent, that actually in Sir John Lawrence's reign the forest establishments under the Government of India were placed on a regular organisation.

Apart from reckless cutting, the improvement of the forests was impeded by two old-established practices, grazing and the jungle fires of the hot season. Two important and interesting chapters are devoted to these subjects, to the efforts made to regulate grazing and to protect the forests against fire. Here it must suffice to state that systematic fire protection was commenced in the Central Provinces in the hot season of 1865. Colonel Pearson, then Conservator of Forests in that province, had serious doubts on the subject; he knew that any attempt to interfere with this ancient institution, which cleared the ground of inconvenient grass and underwood, would be distasteful to all, Europeans as well as natives. With the powerful support of Sir Richard Temple, then Chief Commissioner of the Central Provinces, he made the attempt. He selected the Bori forest in the Satpura range, a district most favourably situated for the experiment. He succeeded, and within a few years he saw the condition of the forest entirely altered. The extensive grasslands and smaller blanks in the forest gradually filled up from the edge with coppice shoots and self-sown seedlings, the soil, which hitherto had been hardened and sterilised by the annual fires became fertile, the trees increased rapidly in height and girth, and the fresh shoots of the bamboo became taller and stouter. Gradually this difficult work was taken in hand in all provinces, and in 1899 no less than 29,492 square miles were successfully protected against fire, or one-third of the total area of reserved forests. The expense of these operations latterly has been between ten and eleven rupees per square mile.

The question will now properly be asked: Who pays for all this business? Forest revenue and expenditure have increased steadily ever since forest business was properly organised. In 1898–99 the results were as follows:

Revenue ...	Rs. 1,90,38,520,	or	1,270,000*l*.
Expenditure ...	,, 1,00,33,920,	,,	670,000*l*.
Surplus ...	,, 90,04,600,	,,	600,000*l*.

This, it is true, is only a small contribution to the annual revenues of the British Indian Empire, which in the same year amounted to 1,01,40,00,000 rupees. But it is something, and the surplus is increasing steadily. Certainly it must increase, for at present it only amounts to 2·7*d*. an acre. In some provinces, fortunately, the surplus is higher. Since the annexation of the kingdom of Burma the reserved forests in this province are:

7,679 square miles in Lower Burma.
7,988 ,, ,, in Upper Burma.

Total 15,667 square miles.

Both in Upper as well as Lower Burma teak timber is the principal and most valuable produce of the forests. The teak forests of Upper Burma had been leased by the King to powerful firms at Rangoon under the vaguest conditions. The lessees were only liable to the payment of a lump sum per annum, without reference to the amount cut by them. Under these conditions the utter devastation of the forests within a short time was inevitable. It has been Mr. Ribbentrop's privilege, after the conquest of the country in 1886, to induce the Government to claim the right of interference, and it is entirely due to the tact and determination with which he conducted the negotiations that a settlement was arrived at, under which no trees can be cut that have not been selected and girdled by the Forest Department. Thus this valuable property was saved from ruin, and it is satisfactory that the last of the leases will shortly expire. The surplus realised by the Burma Forests in 1899 was 59,24,000 rupees, corresponding to 13*d*. an acre. This is better than the amount realised from the whole reserved forests of the British Indian Empire. But even this is a poor result as compared with the yield of properly managed forests in Europe. Of all States of the German Empire, Prussia has, owing to unfavourable soil and climate, the least productive forests, and the average net yield of the State forests is only five shillings an acre, while the State forests of Saxony yield twenty and many forest ranges in that country yield thirty to forty shillings an acre. Much progress, therefore, has still to be made in improving the condition and productiveness of the Indian forests before they can hold their own in comparison with the forests of Europe. This result, however, will be attained provided a sound and vigorous forest policy is continued.

Besides timber, wood and bamboos there are numerous other substances, such as tanning materials, gums and caoutchouc, necessary for the every-day life of the people and required for the commerce of the world, which are produced and will be produced on a much larger scale, provided the forests are efficiently protected and properly managed. From all this a growing surplus revenue may be obtained. There is, however, a class of forest produce more important than all these for the welfare of the country, which cannot be expected to contribute very largely to the surplus forest revenue. This is grass and cattle fodder.

In a hot climate, except in districts with an exceedingly heavy rainfall, a better crop of grass is produced under the shade of trees than in the open, and this is particularly the case in seasons of drought, to which, unfortunately, large portions of India frequently are subject. In the dry climate of Rajputana numerous chiefs and princes had from time immemorial established game-preserves, chiefly as cover for pigs. The forest growth in these preserves was carefully protected, and during the terrible famine

which devastated that country in 1867, 1868 and 1869, they furnished an abundance of grass and branches of trees to feed the cattle of the neighbouring towns and villages. Two small British districts, Ajmere and Merwara, are situated in the midst of these native States of Rajputana. Here the whole of the waste and forest lands at the disposal of Government had, at the settlement of 1850, been handed over to the villagers, the State relinquishing its rights in these lands. The results of this "liberal" policy had been disastrous. The hills had become denuded, the timber was sold, the wood was used and these lands had become utterly barren and unproductive. For their crops the people of these districts almost entirely depend upon irrigation. The water is furnished by numerous ponds or tanks, formed by embankments thrown across valleys at convenient points. Many of these tanks are old, others have been built since the country came under British rule. The scanty rainfall in these districts does not come down continuously, but in a small number of heavy showers. The rain rushed down the denuded hillsides in torrents and, instead of filling the tanks slowly but steadily, burst the embankments or filled the tanks with the silt which the floods had brought down. These districts the writer visited in December 1869. The cattle had perished, the people had fled, large villages were entirely deserted, and the country was almost depopulated by these years of drought and famine. Adjoining the district of Merwara on the east side is the territory of the Thakur of Bednor, a feudatory to the Maharajah of Udaipur, and the contrast was extremely surprising—in British territory the hills denuded, in Bednor the hills wooded, the forest having been carefully protected. From the top of Bairat Hill, on January 2, 1870, we looked down upon the town, with its large tank and beautiful groves of fruit trees, and here the Thakur's eldest son, who had the management of the forest lands, told the writer how the Nasirabad charcoal contractors had come, offering large sums if he would allow them to cut. He had refused and would always refuse their request, knowing well that the grass in the forest and the branches of the trees had saved the cattle of Bednor in seasons of drought, and that the water supply in the tanks, upon which the fertility of the country depended, was maintained by the forest growth on the hills.

After several years' hesitation, action was at last taken, in 1874, to remedy the mistakes which, with the best intentions, had been made in 1850. The Ajmere Forest regulation was passed, which gave the Chief Commissioner of those districts power to take up any tract of waste or hilly land as a State forest, granting the people who had formerly had an interest in that land the right of cutting grass and wood in it for their own requirements and a liberal share in the net proceeds from the management of these lands. This measure, at first sight, might be termed a confiscation of rights deliberately granted. In reality, however, the proprietary rights had at the settlement not been granted to individuals, but to the village communities. They were communal lands, and as such public, not private, property. Government, therefore, as the guardian of all public interests, had the duty to interfere. This small measure, had it been properly followed up, might have been one of the most beneficial measures passed in the reign of Lord Northbrook. Unfortunately, only 139 square miles, or 5 per cent. of the total area, have been demarcated as State forest in Ajmere-Merwara. And worse than this, grazing was frequently allowed without real necessity, and consequently protection remained incomplete. Nevertheless, with all these drawbacks these reserves are now very fairly stocked with trees and shrubs, and they have proved a great protection to these districts in times of drought during the last twenty years.

In the famine, which affected a large portion of the Bombay Presidency in consequence of the short monsoon of 1896, operations were undertaken on a large scale to provide cattle fodder from the forests to all districts which needed such help. Mr. Allan Shuttleworth, the Conservator of Forests, organised and directed these operations. Presses were set up near the forests, roads were constructed, hay was made and pressed in 80 lb. bales, which were despatched by train, and were sold at cost price at depots all over the affected districts. The same plan was pursued in the late famine, and has also been adopted in other provinces. Grain can easily be sent to districts affected by scarcity, the provision of cattle fodder is more difficult, and in previous famines the loss of cattle has always been the chief calamity. When at last rain falls and no cattle are left to plough, the distress is terrible. Millions of cattle have been saved by these measures, and it is to be hoped that the ruling authorities in India will always bear in mind that if in seasons of drought the forests are to be in a position to furnish cattle fodder on a large scale, they must in ordinary years be efficiently protected against fire and must not be indiscriminately opened to cattle.

Besides the areas which are classed as forests, there is in each province a large extent of waste, aggregating upwards of 380,000 square miles, or considerably more than one-third of the entire area of the British provinces. At present these waste lands furnish wretched pasture, the scrub and isolated trees upon them yield fuel, and, on a small scale, wood for building and agricultural implements. One of the most important, but at the same time most difficult, tasks awaiting Indian foresters in the future is to undertake the management of these lands. On a small scale something in this direction has been done by the formation of canal plantations, and the establishment of fuel and fodder reserves in a few districts. But the work must be taken in hand on a much larger scale and on a methodical system in all provinces. Under good management these lands will produce heavier crops of firewood and cattle-fodder. At present manure is used as fuel in most districts, and the result is, in spite of the skill and industry with which the Indian peasant cultivates his land, an exceedingly poor yield of crops. In his report on the improvement of Indian agriculture, Dr. Voelcker justly urges the establishment on a large scale of fuel and fodder reserves, in order to supply wood to take the place of cow-dung as fuel. "If wood," he says, "could be made to take the place of dung for fuel, we should soon come to realise that more wood means more manure, that more manure means heavier crops and an increasing fertility of the soil."

It is not impossible that these measures may eventually lead to the formation of village forests. Experience has shown in Germany, in France and in other countries of Europe, that municipal self-government of towns and villages develops in a healthy manner where these municipalities have landed property, provided it is well and efficiently managed. The communal forests in these countries contribute largely to the prosperity of the agricultural population. They furnish all the wood and timber the villages require, and the sale of the surplus yields a steady annual income, in many cases sufficient to cover the charges of the municipality for roads, schools, churches and other purposes.

In a number of interesting chapters the author explains the nature and extent of the rights which Government possessed in the waste and forest land of the different provinces at the time that the State forest reserves commenced to be established. The British Government had legally succeeded to the rights actually exercised by the former rulers of conquered or ceded States at the time of conquest or cession. Consequently, the unoccupied waste, including forests, as a rule, was the property of the State. In these waste and forest lands, however, the people had grazed their cattle, had cut wood and bamboos for their use, and had cleared land for shifting or permanent cultivation. Under the former native Governments the forests had thus been used by the people, not as of right, but subject to the good pleasure of the ruler. When the preparation of proper forest laws for the different provinces was considered, between 1869 and 1878, the most important question was, to what extent this long-continued user of the Government forests should be regarded as constituting a prescriptive right; and it was deliberately settled that the customary user of the forests under British rule must be held to constitute a prescriptive right. On the other hand, it was acknowledged that Government, as the guardian of all public interests, must insist upon the regulation of these rights, so as to render possible a good management of the reserved forests in the interests of the country.

It was held that the growth of forest rights in India had been analogous to the growth of similar rights of user in Europe, and consequently that the legal provisions for regulating them or, in case of need, for extinguishing them by means of suitable compensation, must be analogous to forest laws made in Europe.

By the Indian Forest Acts the duty of deciding which claims shall be admitted as a right, as well as the regulation and commutation of rights thus admitted, is entrusted to special officers, styled forest settlement officers, and an appeal from their decisions is provided. Under the procedure prescribed by these acts, the 84,148 square miles of reserved forests have been settled. In many cases was it possible to extinguish the rights by suitable compensation; in others the forest remained burdened with rights to pasture or the cutting of wood, but these

rights were strictly defined in regard to area, the number and description of cattle admitted to graze, and the amount of timber to be cut. In many instances the settlement officers have gone far beyond the requirements of the law; they have often been disposed to place heavy burdens upon the Government forests, in order to make matters as comfortable as possible to the people in the vicinity. Especially in regard to pasture, the tendency of most Governments in India has been to insist on cattle being admitted to graze in the forests far in excess of what was prescribed by the forest settlement. Young forest growth cannot come up under heavy grazing. In seasons of drought, as a matter of course, the forests must be, and are, always thrown open. But if this is done in ordinary seasons, the forests cannot improve, and cannot provide what is wanted in times of scarcity.

In these circumstances agitation against forest administration is of frequent occurrence. In his delightful and most important work, "Forty-one Years in India," vol. i. pp. 441, 442, Lord Roberts states: "Amongst the causes which have produced discontent of late years I would mention our forest laws and sanitary regulations, our legislative and fiscal systems—measures so necessary that no one interested in the prosperity of India could cavil at their introduction, but which are so absolutely foreign to native ideas that it is essential they should be applied with the utmost gentleness and circumspection. . . . . The proceedings and regulations of the Forest Department, desirable as they may be from a financial and agricultural point of view, have provoked very great irritation in many parts of India. People who have been accustomed from time immemorial to pick up sticks and graze their cattle on forest lands cannot understand why they should now be forbidden to do so, nor can they realise the necessity for preserving the trees from the chance of being destroyed by fire, a risk to which they were frequently exposed from the native custom of making use of their shelter while cooking, and of burning the undergrowth to enrich the grazing."

In these words Field-Marshal Lord Roberts faithfully expresses the views of many leading public men in India. And yet the development of the British Indian Empire, through railways and telegraphs, through extended irrigation, the steadily growing wealth of its inhabitants, necessitates the maintenance and improvement of its forests, while the persistent growth of the population, in spite of famines, cholera and plague, demands that the large areas of waste lands should produce more cattle-fodder and more firewood. These are demands which cannot be resisted.

A detailed account is given of the Dehra Dun Forest School, which was established in 1878 for the professional training of native forest officers. Of the first director of that institution, Captain (now Colonel) F. Bailey, R.E., the author justly states that it was entirely owing to his exceptional powers of organisation, energy and ability that the new institution took healthy root from the outset. It has been explained at the outset of this article that in 1866 two young forest officers from Germany, Dr. Schlich and Mr. Ribbentrop, were engaged for the Indian forest service. In the same year arrangements were made for the professional training of young Englishmen in the State forests of France and Germany. The first selection was made in 1867, and the first men trained under this system joined their province in 1869. Since then a varying number has been sent out annually. In 1887, after the arrangements in France and Germany had come to an end, the first men arrived, who had been trained under existing arrangements at Coopers Hill. Altogether, until 1899, 207 professionally trained men have gone out, of whom in that year 152 were still in the Indian Forest Service. This number obviously is wholly insufficient to provide for the management of 84,000 square miles of reserved forests. Moreover, the small surplus revenue yielded by these forests would make it out of the question to employ English officers for their management. In the State forests of the kingdom of Saxony, the mean area of a forest range or executive charge is 4000 acres. The executive officer, here styled Oberförster, receives the same professional training, and has the same social standing, as the higher forest officers to whom he is subordinate. Every member of the superior Forest Service begins his career as assistant to the Oberförster, and his first appointment to a responsible post is that of executive officer. This organisation ensures efficiency, because the Oberförster has a reasonable chance, by distinguished service, of rising to the highest appointments in the department.

An organisation as simple and effective as this is impossible in India. The revenue of the forests is too small. Further, the officers must necessarily belong to two classes, expensive Englishmen for the higher appointments, and natives at lower rates of pay for the executive charges, and these two classes cannot be amalgamated. Four thousand acres in Saxony yield a net revenue of 4,000*l*. at 20*s*. an acre; the area required to produce a similar revenue in India would be so large as to be quite unmanageable for one executive officer. Thirty square miles, or 19,200 acres, would be a large but still manageable area in India. From 1888 to 1899 the surplus has doubled, and it is not unreasonable to expect that in 1910 it will amount to 6*d*. an acre. At that rate 30 square miles would yield an annual surplus of 480*l*. By that time there ought, therefore, to be 2800 professionally trained forest officers for the executive charge of these forest ranges. The actual number of forest rangers in the different provinces at present (July 1, 1900) is 425. The organisation, therefore, of executive charges is far from complete. To a great extent the executive management of these estates is at present in the hands of the superior controlling and directing officers, who do the work through the agency of forest guards and other protective officers, men who have received no professional training.

The chief difficulty at present is, that the men who enter the Dehra Dun Forest School belong to a lower social stratum than is desirable. And this will continue until means are found to give forest rangers reasonable prospects of promotion. Something in this direction has been done by establishing a provincial branch of the superior Forest Service, so that from time to time a few really distinguished forest rangers may be promoted. And when the advantage of relying mainly upon native agency in forest business has been fully recognised, means doubtless will be found to improve the prospects of advancement for native forest rangers. No possible political difficulty can arise through employing natives of India in the higher branches of the forest service, and hence it seems right to use this department to make the experiment.

Sir Thomas Munro, one of the most distinguished Indian statesmen in the early part of last century, while Governor of the Madras Presidency, wrote as follows on December 31, 1824: "All offices that can be held by natives without danger to our power might with advantage be left to them," and further on follow remarks to the following effect: "To improve the character of the natives we must open the road to wealth and honour and public employment." Since 1824 the British Indian Empire has not only increased enormously in extent and population, but good government, the security of persons and property, the impartial administration of justice, the growth of commerce and manufactures, irrigation works, roads, telegraphs, railways, and by no means least, schools and colleges, all this has brought about a tide of progress which cannot now be stemmed. But the blessings of progress will be valued more by the people if they are not all dispensed by the hand of the foreigner, if natives themselves are the agents, to a greater extent than is the case at present, in the undertakings which contribute to their well-being.

Mr. Ribbentrop is not an advocate of these plans, yet on several occasions he bears testimony to the excellent work done by natives of India, provided they have received a good professional training in surveying or forestry. A weighty objection is raised by parents in this country that plans like these will take the bread out of their sons' mouths. Latterly from six to eight men, who had received their professional training at Coopers Hill have been sent out annually. It may be regarded as certain that, if all goes well, the number required will increase largely, not only because the management is gradually becoming more intensive, improving the yield capacity of the forests and augmenting the revenue, but also because a constantly increasing number of Indian forest officers are required in native States and other countries, such as Siam, and in the British Colonies. Even should a few more appointments be filled up by the promotion of native forest rangers, the number of men required from Coopers Hill will not diminish but will increase. And surely it is better that a policy should be followed which will tend to place British rule in India upon a safe foundation than that a few more appointments should be available for young men at home. The beneficial effects of forestry will not be fully realised until it ceases to be an exotic plant. The educated natives of India must feel that they are the allies of the British Government, and this can only be brought about by giving them

a larger share in all works undertaken to promote the welfare of their country.

The author does not claim to be a botanist, nor does Dr. Schlich, who preceded Mr. Ribbentrop, nor does their successor, Mr. H. C. Hill, the present Inspector-General of Forests. It is necessary to mention this because in England, also among scientific men, the opinion prevails that forestry is a branch of botany, and that a forester who is not a botanist cannot claim to be a scientific man. Dr. Schlich's great merit while holding the appointment in India was to organise that branch of forestry which deals with the plans regulating the working of the forests, a business which is based more upon mathematics than upon botany. Mr. Ribbentrop's great achievement has been to study and correctly to appreciate the peculiar sylvicultural requirements of the great variety of trees and bamboos with which the forester has to deal in India. Through his labours the management of teak, of sal, sissoo, deodar, and of other important trees when growing by themselves or in company with other kinds or with bamboos, their regeneration, natural or artificial, and their subsequent treatment under different conditions of soil and climate, is much better understood now than it was twenty years ago. These are great results, which, provided no retrograde measures are adopted, will bear fruit in steadily increasing the productive powers and capital value of the forests, and will contribute largely to the welfare of the millions inhabiting the British Indian Empire.

DIETRICH BRANDIS.

SUBMARINE BOATS.

THE building of five submarine boats for the British Navy not only forms quite a new departure but also, perhaps, the advent of the nucleus for an instrument of war of novel design. The boats (says *Engineering*, March 29), which are being built by Messrs. Vickers, Sons and Maxim, Ltd., are of the *Holland* improved type and are 63 ft. 4 in. in length over all, 11 ft. 9 in. beam, and 120 tons displacement submerged, and they will be capable of expelling torpedoes either with the boat at rest, during the run on the surface, or steaming at any speed submerged. When running on the surface the boats will be propelled by a gasoline engine (of marine type, inverted, and with four single acting cylinders). The amount of fuel carried will suffice for a run of about 400 miles with a maximum speed of about 9 knots, and when submerged an electric motor of the waterproof type, worked with storage batteries, will give the vessel a speed of seven knots, which can be maintained for four hours. The general operation of the boat is given as follows:—"Before it is desired to make a dive, the boat is brought to 'awash' condition, with only the conning tower ports above the water. The dive is then made at a small angle until the proper depth is reached, when by automatic means the boat is brought to a horizontal position. After the discharge of the torpedo from the fixed bow tube, the compensation for the weight of the torpedo is made automatically, causing only a slight change of trim for a few seconds. Provision is made for quick rising and diving, the time of appearance of the conning tower above the water being dependent on the skill of the navigator." In the United States Navy the *Holland* has undergone most exacting trials and has proved herself "stable in service working," and it is here we get the most convincing testimony, where Admiral Hitchborn, chief constructor in the United States Navy, states in his official report, "The *Holland* has shown herself capable of such complete control in the vertical plane that she may be kept within a few inches of any desired depth while moving, or brought to the surface and taken under again in a very short time: her direction and control in the horizontal plane on the surface is effected with the same facility as any other craft, and submerged is limited only by the difficulties of vision: her crew are provided for on board with reasonable comfort and perfect safety for such periods as she may be in service and working either upon the surface or submerged; and her armament, consisting entirely of torpedoes, gives her great offensive power."

THE CURRENTS IN THE GULF OF ST. LAWRENCE.

IN a former article (January 24, 1901, p. 311) we gave a summary, from a pamphlet recently issued, on the currents in the Gulf of St. Lawrence, in which we noticed some points of general application to similar researches elsewhere. This pamphlet, issued by the Department of Marine and Fisheries, Canada, gives concisely the results of investigations in the summer seasons of three years in that Gulf, conducted by Mr. W. Bell Dawson, in charge of the Survey of Tides and Currents. It is primarily for the benefit of practical seamen; but it also contains an explanation of the hydrography of the Gulf, on which this Survey has thrown considerable light; and it is this part that we now summarise.

General Characteristics of the Gulf of St. Lawrence.—With the exception of the currents in the various straits and near the heads of the bays, the currents met with in the open Gulf seldom exceed one knot. They are, therefore, the more easily influenced by strong winds, especially at the surface of the water. Currents which have a greater speed than this are found in Belle Isle and Cabot Straits, in Northumberland Strait, off the Gapsé coast, in the Gut of Canso, and locally in channels between islands and at the mouths of rivers.

The water of the Gulf may be roughly divided by a line running from South-west Point of Anticosti to the middle of Cabot Strait. Along the south-western side of this line the water has a lower density, as it is apparently made a little fresher by the outflow of the St. Lawrence River. To the north-east of this line, throughout the north-eastern arm of the Gulf, the water has the same density as in the open Atlantic.

The general drift of this water of lower density is outward, towards the Atlantic. This gives rise to two constant currents, one at the mouth of the St. Lawrence along the Gaspé coast, which may be called the "Gaspé Current," and the other on the west side of Cabot Strait around Cape North, which may be called the "Cape Breton Current." A third constant current is found on the west side of Newfoundland, making north-eastward from the Bay of Islands towards Rich Point.

It is to be noted that in calling these currents constant it is only meant that they usually or most frequently run in the one direction. During certain winds they may be much disturbed, or their direction may even be reversed.

Temperature.—It appears that in general the temperature of the surface water merely rises with the progress of the season; and it is also natural that the water should become warmer to a greater depth as the season advances. Even this has its limitations, however; as at a depth of 50 fathoms no greater rise in temperature has yet been found than from 32° to 34°, between the month of June and the end of September.

At all three angles of the Gulf it was found that the coldest water forms a layer between the depths of 30 and 50 fathoms. In the vicinity of Belle Isle Strait, the same low temperatures are also found at these depths; although there the temperature towards the surface is relatively lower, as a rule, than in other regions. It is probable that this cold layer extends very generally over the Gulf area. Below this cold layer, in the deep channel of the Gulf, the temperature from 100 to 200 fathoms is found to range very constantly from 38° to 41°. This result was obtained in Cabot Strait, and also between the Gaspé coast and Anticosti, 220 miles further in from the Atlantic, along the deep channel. This deep channel runs into the Gulf from the Atlantic basin through Cabot Strait, and maintains a continuous depth of some 200 fathoms across the middle of the Gulf to the mouth of the St. Lawrence River. It still has a depth of 100 fathoms half-way up the estuary on the Lower St. Lawrence.

Density.—It may be stated broadly that throughout the north-eastern portion of the Gulf the average surface density ranges from 1·0235 to nearly 1·0245; while in the south-western portion the density is below 1·0235, ranging usually down to 1·0220, and falling in the Gaspé Current itself to 1·0210. The dividing line between these two portions of the Gulf runs approximately from South-west Point, Anticosti, to a point in the middle of Cabot Strait. The densities in the border region near this dividing line naturally vary to some extent. The density of the north-eastern portion is practically the same as in the open Atlantic, as it was there found to range from 1·0237 to 1·0242, as shown by seven determinations made at the end of June off the south and south-east coasts of Nova Scotia.

This result is important in showing that the lower densities found in the south-western portion of the Gulf of St. Lawrence are confined to that side; and this also accords with the conclusion that the general set or drift across the Gulf is in the direction of a line from Gaspé to Cape Breton. On the other hand, the endeavour to obtain some differences locally, which would correspond with the various directions of the current, was without result; although a large number of temperatures as well as densities were taken for this purpose.

The deep water as found from samples taken at depths of 100

and 150 fathoms, both in the vicinity of Gaspé and in Cabot Strait, ranges in density from 1·0254 to 1·0261. The density of this deep water is very interesting in affording an explanation for the otherwise anomalous fact that the colder water at 50 fathoms is found to float upon it. It also corresponds with the density at similar depths, off the coast of Nova Scotia.

Current across the Gulf area.—The general connection of the Gaspé and Cape Breton currents became evident when it was ascertained that the water of lower density kept to the south-western side of the Gulf. The observations of the current in open, and the reports from steamships, also accord with a general movement of the water towards the south-east, as this is the more usual direction, and the currents which are found at times to run across this prevailing direction are to be attributed to the influence of the tides and the wind.

As to the route taken by the water in traversing the Gulf from the Gaspé region to Cape Breton, it seems fair to conclude, from the evidence furnished by the density observations, that the greater proportion finds its way eastward between the Magdalen Islands and Prince Edward Island, while a certain amount may also pass north of the Magdalen Islands, on the line from Bird Rocks to St. Paul Island. It is probable, also, that some of the water may come from Northumberland Strait, as the water there is also low in its density.

For a discussion of the probable reasons why the water of lower density keeps to the south-western side of the Gulf, the Reports of the Tidal Survey may be referred to.

The St. Lawrence River in relation to the outflow from the Gulf.—It can hardly be doubted that the low density of the water in the Gaspé Current is to be attributed to the outflow of the St. Lawrence River; and we are thus able to trace the influence of this water as far as Cape Breton, where it finally mingles with the water of the Ocean. The volume discharged by the St. Lawrence has been measured at different seasons, and with the addition of the principal tributaries along its estuary, the total volume of fresh-water discharge would probably amount in all to 340,000 cubic feet per second. This volume of fresh water will mingle with sea water for which we may assume a density of 1·0240, as this may be taken to represent either the mean density of Atlantic coast water to a moderate depth, or the density of the salter water in the Gulf itself. Under these conditions, the fresh water of the St. Lawrence would be sufficient to furnish a stream of water reduced to the lower density of 1·0230 which would be twelve miles wide and 68 feet deep, and moving with a speed of one knot per hour. This would represent the average density of the Gaspé Current, and would probably be an approximation to its average speed and its volume; and such a comparison may therefore serve to illustrate the way in which the conditions may be accounted for, if the data themselves were more closely known.

It is to be noted, however, that as regards volume the St. Lawrence River is almost insignificant as compared with the outflow of the Gaspé Current. This current, whether it flows near the coast or in the middle of the passage between Gaspé and Anticosti, has usually a width of about twelve miles. The total depth immediately off this coast is over 100 fathoms, and the depth or thickness of the current itself was ascertained from measurements of the under-current taken as far down as 30 fathoms, at times when the surface speed varied, as usual, between one and two knots. It results from these measurements that we may consider the volume of this current to be represented by a body of water 12 miles in width, with a mean depth of 30 fathoms, and moving with an average speed of 0·68 knot per hour, throughout this depth.

Such a current has a volume forty-three times greater than that of the St. Lawrence River. The volume of the Cape Breton Current, also, is probably much the same. These outflows must therefore be replaced by a return movement at the entrance to the Lower St. Lawrence, somewhere in the Anticosti region; and also by a return flow from the Ocean into the Gulf area, as the discharge of the St. Lawrence furnishes less than 3 per cent. of the amount required in either case.

The current which usually makes inwards around Cape Ray on the east side of Cabot Strait may be sufficient to compensate for the outflowing water of the Cape Breton Current; although it is also possible that the outflow from the Gulf may be partly made up for by the difference of flow in the inward direction through Belle Isle Strait, which in some years may be considerable in the early spring. This inflow at Cape Ray is in continuation of the general westward tendency of the water along the south coast of Newfoundland. The quiescence of the deep water in Cabot Strait is also to be noted in this connection.

It may be well to remark, however, that although the outflowing water of the Cape Breton Current is much warmer in the summer season than the incoming Atlantic water, it is not so at all seasons of the year. While it is probable that the total result is on the side of loss of temperature to the Gulf area, it would require extended observations throughout the year to ascertain the amount of loss and the probable effect, in consequence, upon climate in the surrounding regions.

The Current in Belle Isle Strait, in relation to the Gulf area as a whole.—On account of the tidal character of the current in Belle Isle Strait it is clear that no great volume of water can enter the Gulf of St. Lawrence from that quarter.

During the summer season the current flows in the Strait with a speed which is nearly equal in each direction; and there is only a difference in favour of inward flow to the west, which on the whole does not probably amount to more than a moderate percentage. From the discussion of all the evidence secured, it is perhaps possible that in the early spring the preponderance of inward flow may be proportionally greater than at other seasons. But no reasons have been found for supposing that this water passes completely round the west coast of Newfoundland and finds its way out into the Atlantic through Cabot Strait, between Cape North and Cape Ray, in accordance with the theory which has been more or less accepted up to the present time. All the indications are against this theory, as they show that any general current across the extent of the Gulf must lie in an entirely different direction. The reasons for this conclusion are discussed in the Tidal Survey Reports, in which the tidal character of the flow in this Strait is described and the relations of the current to the tide, the temperature of the water and the drift of icebergs are fully explained. A diagram showing the flow of the current in the two directions as observed is also given.

General Circulation in the Gulf.—In reviewing the movements of the water, with a view to tracing the general circulation in the Gulf, it is the principle of the balance of flow which is the most evident. Wherever a current of a constant character occurs, there is a corresponding return current to make up for it. Thus in Cabot Strait, the outflowing water in the Cape Breton Current is balanced by the inflow at Cape Ray; the north-eastward current on the west coast of Newfoundland is balanced by the contrary direction of the movement on the opposite shore; and we have fairly good indications of a return flow to compensate for the Gaspé Current.

It is this balance of flow which points to the nature and direction of the circulation of water in the Gulf. If we begin to trace it from Cabot Strait, where the balance between the Gulf and the Ocean takes place, the inflow at Cape Ray appears to diffuse itself more or less widely over the central part of the Gulf, but it regains its strength further north on the west coast of Newfoundland, and makes a deep bend into the north-eastern angle of the Gulf, and returns westward along the north shore. On reaching Cape Whittle it still makes westward; and, whether as an actual set or by displacing water which comes more directly from Cape Ray, it appears to work around the eastern end of Anticosti, and so compensates for the outflow of the Gaspé Current, from the estuary of the St. Lawrence. This current, after rounding the Gaspé coast, makes south-eastward as a general set or drift across the Gulf to the western side of Cabot Strait; and its waters there leave the Gulf in the outflow of the Cape Breton Current.

It also appears that the whole of the balance or compensation in the Gulf currents takes place at the surface and in ordinary under-currents, which do not probably extend to a greater depth than 50 or 60 fathoms at the most. There is nothing, therefore, to show the necessity for any appreciable movement in the deep water from 60 to 80 fathoms downward, which lies in the deep channels of the Gulf. Where direct observations have been obtained, this deep water appears to lie quiescent, without any movement that can be detected.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Prof. T. Hudson Beare, professor of mechanical engineering at University College, London, has been appointed to the Chair of Engineering in the University of Edinburgh, in succession to the late Prof. Armstrong.

Mr. J. W. Pulsford, late scholar of Sidney Sussex College, Cambridge, and second master of the Dorchester Grammar School, has been appointed a junior mathematical teacher in the Merchant Venturers' Technical College, Bristol.

Sir W. H. Preece, K.C.B., F.R.S., will distribute the prizes and certificates to the students of the South-Western Polytechnic, Chelsea, on Saturday. The laboratories will be open for the exhibition of apparatus and experiment, and short lectures will be given in the course of the evening.

The movement in favour of the establishment of a Liverpool University has received an impulse by the offer of Mr. A. L. Jones to contribute 5000*l.* towards that purpose. With the University College as a centre of activity, and the interest taken in educational matters in Liverpool, the movement ought soon to assume a practical form. At a special meeting of the council of University College, held on Tuesday, the following resolutions were adopted:—(1) That, while gratefully acknowledging the advantages which have accrued to University College, Liverpool, by its association with Victoria University, this council is of opinion that a University should be established in the city of Liverpool; that this council will welcome a scheme with this object upon an adequate basis; and that a committee be appointed to consider and report upon the whole question, with power to make inquiries and to communicate with other bodies. (2) That the committee consist of all the members of council, with power to associate with them any other persons whom they may think fit.

Sir William Hart Dyke presided at the annual meeting of the Association of Technical Institutions on Tuesday, and delivered an address, in the course of which he dealt with the necessity of a coordinated educational system, educational and industrial progress in America, the educational crisis produced by the decision as to the limitation of the powers of School Boards as regards higher grade and evening continuation schools, and the constitution of local authorities to be responsible for educational provision. Several resolutions were passed, among them being one approving the main provisions of the Secondary Education Bill, 1900, and hoping that the new Education Bill promised by the Government will prevent unnecessary and wasteful overlapping and competition between the educational work of School Boards and County Councils.

At a meeting of Convocation of the University of London, held on Friday last, a resolution was carried to the effect:—"That the life composition fees paid by the graduates in lieu of annual subscriptions to Convocation, being the capital of the University, ought not to be retained by the Treasury; and that the Senate of the University be hereby requested to represent to the Chancellor of the Exchequer that the University is the equitable owner of the same." In proposing the resolution Prof. S. P. Thompson compared the London University with other Universities as regards the support given to it. He pointed out that the University of Berlin has 5140 students and that the State subvention is more than 105,000*l.* per annum, making about 21*l.* per student. The University of Rostock, with 514 students, has a State subvention of 17,000*l.*, or about 33*l.* per student, and the annual State subvention at Strassburg amounts to 44*l.* per student. The University of Edinburgh, with 2780 students, has a Parliamentary grant of 25,870*l.*, or about 9*l.* per student; and the University of St. Andrews, with 236 students, enjoys a grant of 10,800*l.*, or 45*l.* per student per annum.

To all who are interested in the subject of education in country districts we recommend for serious consideration a small pamphlet which we have received from the Board of Education and which bears the title "Specimen Courses of Object Lessons on Common Things connected with Rural Life and Industries for all Classes in Rural Schools." It has long been recognised by educational authorities that there should be a differentiation between urban and rural education, and two years ago Sir John Gorst, in the course of a speech delivered at the Countess of Warwick's school near Dunmow, dwelt upon this necessity with his accustomed vigour of expression. Since that time the Agricultural Education Committee have been working most energetically to bring about this much-desired result, and the manifesto of the Board of Education may in some degree be looked upon as one of the practical issues of the voluntary labours of the gentlemen composing that Committee. Of course in all educational reforms in this country the usual difficulties of vested interests, inelasticity of teachers, hostility of those who fail to see the importance of nature knowledge, &c., have to be faced and, if possible, overcome. The schedules now issued should go a long way towards removing these difficulties, and it is satisfactory to learn from the introductory statement that the schemes submitted are actual examples of attempts now being made to adapt the teaching in rural schools to the requirements of country life. One paragraph, pointing out the connection of the new schemes with other studies, strikes us as being an admirable answer to those objectors who declare that the introduction of these rural subjects entails the subordination or suppression of other necessary subjects. It is shown most conclusively in this paragraph that no additional burden is imposed upon the teachers or pupils, but simply a "change in the contents of the lessons in the ordinary subjects." The Board recognise that the desired change can only be brought about gradually. It is not often that we find a Government Department actually in advance of the times, but in the present case we certainly must credit the Board of Education with having made a most important step in the right direction.

SOCIETIES AND ACADEMIES.

London.

Zoological Society, April 2.—Dr. Albert Günther, F.R.S., vice-president, in the chair.—Mr. G. P. Mudge read a paper on the myology of the tongue of parrots, and added a tentative classification of this order of birds placed upon the structure of the tongue. This memoir was the outcome of an examination of the tongues of fifty-three parrots ranging over the whole order, the Cyclopsittacidæ excepted; and the conclusion arrived at by the author was that the parrots, by the structural characters of the tongue alone, might be arranged in three families, viz. Loriidæ, Nestoridæ and Psittacidæ.—A communication was read from Prof. W. Blaxland Benham on the larynx of a rorqual whale (*Balaenoptera rostrata*) and of a cachalot of the genus *Cogia*. The paper was based upon an examination of the larynxes of specimens of these cetaceans, which had been washed up on the coast of Dunedin, New Zealand, and in it the author showed how widely different this organ was in these representatives of the Mystacoceti and the Odontoceti.—A communication from Mr. F. F. Laidlaw contained an account of the lizards collected during the "Skeat Expedition" to the Malay Peninsula in 1899-1900. Twenty-seven species were enumerated in the paper, and notes were given on their geographical distribution and habits, special attention being directed to the curious habit of *Tachydromus sexlineatus* of running about on the top of the long buffalo-grass. One new species was described, under the name *Lygosoma floweri*.—Prof. D'Arcy W. Thompson, C.B., read a paper on the pterylosis of the giant humming-bird, *Patagona gigas*.

Entomological Society, April 3.—Mr. Charles G. Barrett, vice-president, in the chair.—The Rev. A. E. Eaton sent for exhibition, on behalf of Mr. F. M. Halford a ♀ sub-imago of a species of *Ephemeridae* of the genus Ephemera, received from Central Africa, without more precise indication of locality, this being the first time this genus has been noticed from Africa.—Mr. McLachlan remarked that Ephemera usually occurred in cold alpine or temperate regions, and that the Central African example probably inhabited the mountains at a considerable altitude.—Dr. Chapman exhibited cases of *Luffia ferchaultella* from Cannes, and a spider, which are found on the same rocks, the interest of the specimens being in the fact that the spider when at rest has almost precisely the same form and coloration as the cases of the moth.—Mr. W. L. Distant communicated a paper entitled "Enumeration of the Heteroptera (Rhynchota) collected by Leonardo Fea in Burma and its Vicinity."

Manchester.

Literary and Philosophical Society, April 2.—Prof. Horace Lamb, F.R.S., president, in the chair.—Mr. W. E. Hoyle exhibited an old form of dial, bearing the name "Nathaniell Jeynes" and the date "1678," which had on one side a small circular rotating plate inscribed with the circumpolar constellations.—Mr. C. E. Stromeyer mentioned that on several occasions he had seen the sun's rays converging to a point directly opposite to the sun. In one case, when the sun was very low on the western horizon, some very marked rays, caused by a low bank of clouds, converged to a point above the eastern horizon.

—The president communicated some numerical illustrations of the diffraction of sound. These were intended to show the extreme facility with which sounds of relatively large wave-length can make their way round obstacles or through apertures. Thus, with a wave-length of 4 feet, a wire $\frac{1}{50}$ of an inch in diameter dissipates only the fraction $6 \cdot 6 \times 10^{-8}$ of the energy which falls upon it; a spherule of water $\frac{1}{1000}$ of an inch in diameter scatters only $1 \cdot 3 \times 10^{-16}$. Again, a perforated screen or grating may present hardly any obstacle to the transmission of sound, although the apertures occupy only a small proportion of the total area. Reference was made to the bearing of such results on the attempts made to improve the acoustic properties of buildings by hanging wires, and on current notions as to the possibility of the reflection of sound from clouds.

Paris.

Academy of Sciences, April 9.—M. Fouqué in the chair.—On the scientific utility of an auxiliary international language, by M. H. Sebert. This language should be capable of being used for the ordinary intercourse of social life, for commercial purposes and for scientific reports; it should be easy of acquisition, and it ought not to be an existing language. Nor can a dead language be used, even if its grammar were simplified and its vocabulary enriched. The creation of a new artificial language alone permits the realisation of simplicity and the unity of method to be obtained by the union of elements borrowed from different living tongues.—On the services which the auxiliary international language of M. le Dr. Zamenhof, known under the name of *Esperanto*, can render to science, by M. Ch. Méray.—Generalisation of Trouton's law, by M. de Forcrand. In all chemical or physical phenomena the heat of solidification of any gas is proportional to its temperature of vaporisation under atmospheric pressure.—New method of distinguishing colouring matters, application to the indophenols, by MM. C. Camichel and P. Bayrac. The absorption of light by solutions of indophenols in alcohol, ether, carbon bisulphide and chloroform has been studied. Taking wave-lengths as abscissæ and coefficients of transmission as ordinates, curves of the form of the parabola were obtained with the convex side towards the axis of abscissæ; the branch of the curve corresponding to the red rises much more rapidly than that corresponding to the green or blue. To distinguish each of the compounds studied, the lowest point of the curve was determined—that is, the minimum transparency. This minimum is independent of the concentration for all the compounds of which the coefficient of absorption is proportional to the concentration, following Beer's law; it varies with the solvent in a manner different from that noticed by Kundt.—On the reaction of the amidobenzophenones and the aromatic amines in the presence of sulphuric acid, by M. Paul Lemoult. In the presence of sulphuric acid the paramidobenzophenones give with certain aromatic amines, to the exclusion of others, reaction products which are colouring matters; the only amines capable of this reaction are those which have at least two aromatic groups directly united with nitrogen; it is necessary, moreover, that one of these be a phenyl group, and that its para-position be free, the nitrogen being in 1.—The angle limiting the numeration of objects and the movements of the eyes, by MM. André Broca and D. Sulzer.—Is the resistance of Algerian sheep to foot-rot hereditary? by M. P. Pourquier.—On Koswite, a new pyroxenite from the Ural Mountains, by MM. L. Duparc and F. Pearce.—On the "blood rain" observed at Palermo in the night of the 9th to 10th March, 1901, by M. Stanislas Meunier. In a hundred parts of the powder were found, water, 5·20; organic matter, 3·17; sand, 59·14; carbonate of lime, 23·91; and (by difference) clay, 8·58.—On the oxidation of iron protosulphide, by M. Gay-Lancermin.

DIARY OF SOCIETIES.

THURSDAY, April 18.

Royal Institution, at 3.—Naturalism in Italian Painting: Roger Fry.
Society of Arts (Indian Section), at 4.30.—Madras, the Southern Satrapy: J. D. Rees.
Röntgen Society, at 8.—Meeting for Discussion. Subject: X-Ray Therapeutics: To be opened by Miss M. M. Sharpe.
Chemical Society, at 8.—Researches on Moorland Waters. Part II. On the Origin of the Combined Chlorine: W. Ackroyd.—Robinin, Violaquercitrin, and Osyritrin: A. G. Perkin.—Preparation of Orthodimethoxybenzoin, and a New Method of preparing Salicylaldehydemethylether: J. C. Irvine.—(1) Action of Alkyl Haloids on Aldoximes and Ketoximes, Part II. (2) The Supposed Existence of Two Isomeric Triethyloxamines: Wyndham R. Dunstan and E. Goulding.—(1) Nitrocamphene, Aminocamphene, and Hydroxycamphene; (2) Action of Hydroxylamine on the Anhydrides of Bromonitrocamphane: M. O. Forster.—The Influence of Cane Sugar on the Conductivities of Potassium Chloride and Potassium Hydroxide, with Evidence of Salt Formation in the Latter Case: C. J. Martin and O. Masson.
Institution of Electrical Engineers, at 8.—Replies of Mr. H. Ravenshaw and Mr. S. F. Walker to the Discussion on their Papers read at the last Meeting.—Test-Room Methods of Alternate Current Measurements: A. Campbell.—Note on the Use of the Differential Galvanometer: C. W. S. Crawley.

FRIDAY, April 19.

Royal Institution, at 9.—The Existence of Bodies Smaller than Atoms: Prof. J. J. Thomson, F.R.S.
Institution of Civil Engineers, at 8.—The Theory of Cast-Iron Beams: E. V. Clark.
Institution of Mechanical Engineers, at 8.—Address by the President, W. H. Maw.

SATURDAY, April 20.

Royal Institution, at 3.—Climate: its Causes and Effects: J. Y. Buchanan, F.R.S.

MONDAY, April 22.

Society of Arts, at 8.—Alloys: Sir W. C. Roberts-Austen, K.C.B., F.R.S.

TUESDAY, April 23.

Royal Institution, at 3.—Cellular Physiology, with Special Reference to the Enzymes and Ferments: Dr. A. Macfadyen.
Royal Statistical Society, at 5.

WEDNESDAY, April 24.

Society of Arts, at 8.—Patent Law Reform: Alexander Siemens.
Geological Society, at 8.—Notes on Two Well-Sections: Rev. R. Ashington Bullen.—(1) On the Geological and Physical Development of Antigua; (2) On the Geological and Physical Development of Guadeloupe; (3) On the Geological and Physical Development of Anguilla, St. Martin, St. Bartholomew, and Sombrero; (4) On the Geological and Physical Development of the St. Christopher Chain and Saba Banks: Prof. J. W. Spencer.

THURSDAY, April 25.

Royal Institution, at 3.—Naturalism in Italian Painting: Roger Fry.
Institution of Electrical Engineers, at 8.
Institution of Civil Engineers, at 8.—"James Forrest" Lecture—On Chemistry in its Relations to Engineering: Prof. Frank Clowes.

FRIDAY, April 26.

Royal Institution, at 9.—Colour in the Amphibia: Dr. Hans Gadow, F.R.S.
Society of Arts, at 8.—Polyphase Electric Working: Alfred C. Eborall.
Physical Society, at 5.—On the Thermodynamical Correction of the Gas Thermometer: Prof. Callendar, F.R.S.—On the Production of a Bright-line Spectrum by Anomalous Dispersion and its Application to the Flash-Spectrum: Prof. R. W. Wood.

SATURDAY, April 27.

Royal Institution, at 3.—Climate: its Causes and its Effects: J. Y. Buchanan, F.R.S.

CONTENTS.

THURSDAY, APRIL 25, 1901.

KORSCHELT AND HEIDER'S EMBRYOLOGY.

Text-Book of the Embryology of Invertebrates. By Profs. Korschelt and Heider. Translated by M. Bernard. Vol. ii., 1899 (pp. xv+375); Vol. iii., 1899 (pp. xii + 441); Vol. iv., 1900 (pp. xi+594). (London: Swan Sonnenschein and Co., Ltd.)

WE welcome with great satisfaction the publication of Parts ii., iii. and iv. of this important work. Originally issued in German in three parts, the first two of which were reviewed in these columns in 1891 (vol. xlv. p. 145), the English translation was issued in four parts, the first of which was published in 1896, the second and third in 1899, and the fourth part in 1900. In the somewhat considerable interval which has elapsed between the issue of the original work and that of its English translation, extensive additions have been made to our knowledge in several departments of embryology. These have been met by editorial footnotes and supplementary lists of literature. The latter appear to have been carefully compiled and will be found by students to have great utility. Indeed, it may be said that, so far as the literature is concerned, Parts ii., iii. and iv. are up to date, and there can be no question that they will be of the greatest value to English zoologists. All that was said in praise of the work in the review of Part i. (NATURE, 1896, vol. liii. p. 361) applies with almost greater force to the volumes before us. They constitute an accurate and comprehensive treatise on invertebrate embryology, and no zoologist's library can be considered complete without them.

The work of the translator and editor also appears to us to have been excellently carried out. The style is clear and the work in its English form is eminently readable. We congratulate the editor upon his sensible decision to translate the German word "anlage" by its English equivalent, "rudiment," and we entirely agree with his remarks in the preface to Part i. on the subject. In opposition to him, however, we think that his restoration of the word "rudiment" to its proper use in embryology will satisfy, if not all zoologists, at least all intelligent zoologists. The word has no biological application outside embryology. In embryos alone can we actually see the first rough outline gradually shaping itself into the perfect organ; and there can be no question that we are dealing with a rudiment. But the same cannot be said when the word is applied to organs of the adult. These undergo no change, except retrogressive changes; and to apply the word "rudimentary" to them implies the possession of prophetic power. We mean, if we apply the word "rudimentary" to an adult organ, that in some remote descendant of the animal under consideration the organ will become more perfect as the result of evolutionary change. This is an entirely gratuitous assumption, which we have no right seriously to make. The word "vestige," the use of which our editor also discusses, is on a very similar footing. It may be appropriately applied to organs which undergo regression, after having attained a more perfect structure in the earlier phases of growth, but do not totally disappear; but it cannot legitimately be applied to adult organs on any other condition. For to call an adult organ, which has not undergone such regression, "vestigial," implies a knowledge of the past, which we have not got, just as rudiment, when applied to adults, implies a knowledge of the future. It may be that the small and imperfect muscles of the outer ear of man are vestiges of more perfectly developed muscles in a remote ancestor, but we have no knowledge that they are so; this view of them is a mere presumption, based on no fact whatsoever. To apply the word "vestigial" (unless the above-mentioned condition be satisfied) or "rudimentary" to adult organs is merely to beg the question at issue, and we require another word to apply to organs which we may feel tempted to designate in that manner. The same remark applies to those organs of the embryo like the neurenteric canal or gill slits of vertebrata, which make their appearance in development but give rise to no structures in the later stages or adult.

As a general rule in German works, the treatment of cœlom and body-cavity is not up to date. Our authors, we are glad to see, are not open to serious blame in this respect, but they have not been able entirely to shake themselves free of traditional conceptions with regard to these structures. They constantly make use of the words pseudococle, primary body-cavity, secondary body-cavity, which all belong to a past epoch of morphology; and they sometimes use language which might lead the reader to suppose that they do not distinguish clearly between hæmocœle and cœlom (iii. 90). Moreover, in dealing with cases in which the nephridia are actually transformations of the cœlom in the ontogeny, they speak of them as though they were really only secondarily related to it (iii. 205). But, in spite of this, it must be admitted that their ideas on these subjects are more advanced than has been usual with German authors.

As was stated in the review of Part i. of this work, the standpoint of our authors is that of the seventies and early eighties of last century. This is clearly seen in their discussions on ancestral derivation, in their chapters on general considerations (which, in our opinion, are too long and often somewhat tedious); in their treatment of the layer-theory, in spite of such statements as those given on p. 301 of Part iv., by which it is shown that the central nervous system arises from ectodermal rudiments which also give rise to mesoderm; in their frequent inability to accept observations which depart at all from traditional conceptions, as witness their treatment, on pp. 166 and 169 of Part iii., of Sedgwick's observations on the cleavage and derivation of the enteron of *Peripatus capensis*. We do not make these remarks in any way to detract from the merit of our authors' work. Morphology is at present in a transition state, and naturalists do not readily part with the old hopes and beliefs which fired them with so much enthusiasm in the early Darwinian days and spurred them on to make those comprehensive researches of which this book is such a worthy record.

CHEMISTRY FROM HARVARD.

Elementary Studies in Chemistry. By Joseph Torrey junr., Instructor in Harvard University. Pp. viii+487. (Westminster: Archibald Constable and Co., Ltd. 1900.)

THIS book is written with an evident desire to present elementary chemistry in such a way as to give full effect to its educational capabilities without neglecting other ends and without a sacrifice of those external features of interest which in the past have covered such a multitude of sins. Mr. Torrey has, in fact, had but one aim, and that to make the best of his subject. A spirit of entire forgetfulness of examiners and syllabuses pervades the work, and things and theories are dealt with according to their intrinsic importance. To say so much is to say a great deal in favour of the book, and to this it must yet be added that the author writes like a practised and enlightened teacher. English teachers of chemistry, both in secondary schools and colleges, will do well to look at Mr. Torrey's book, if only to see the sort of thing that is put forward from Harvard as a suitable course of elementary chemistry. It must be remarked, however, that the course is not intended for quite the same class of pupil that in this country has in recent years been supplied with reformed courses of elementary science. Mr. Torrey's course seems intended for the later stages of the secondary school or for beginners in a college.

To point out the essential difference of plan between teaching chemistry in a stimulating way and teaching it in a deadening way would be to repeat what has often been said before in these columns. It is becoming the habit to summarise these two plans in the words heuristic and didactic, and these philosophical terms have acquired something of the character of verbal missiles, to be hurled by contending parties as weapons of offence.

Two main contentions are heard against the feasibility of improved methods of science teaching. The first is to the effect that a certain proportion of youth have a natural repugnance to science, even in its most inviting form. They refuse to be interested, they will not find out; therefore they must be told things and made to listen and repeat. It seems very doubtful whether this allegation does not very frequently arise from an injudicious or a too impatient teacher, or from one who has the misfortune to deal with good material already spoiled by bad treatment. Where it is wholly true the reply would be, let such pupils be tried with some other subject. If the same resistance continues to be shown, we surely are dealing with something akin to the deficient or feeble-minded class for which at last some separate treatment must be provided. It seems an unfortunate conclusion to reach, that because a good method does not appeal to all, it should be alloyed with an inferior one for the sake of a few.

The second contention is that a good course of science teaching presents difficulties from the examinational standpoint. This is, unfortunately, only too true. It is, undoubtedly, a great practical obstacle, and its removal can only be looked for when further abatement has taken place in the rigour of the whole examinational system, which holds so many good teachers of all subjects in its paralysing grasp.

It is difficult to give in narrow limits an indication of the sequence and style of Mr. Torrey's course. The book is written in the form of short lectures of a suggestive kind, followed by indications of the laboratory work to be done in connection with, or consequent upon, the lectures. It begins with physical topics, including certain measurements, thermometry, vapour pressure and density of gases. The chemistry begins with hydrogen and the composition of water, which is to be studied quantitatively; the composition of hydrogen chloride is then dealt with, in order to accumulate enough material for a discussion of Avogadro's theory. Then follow oxidation, symbols and formulæ, determination of atomic weights, acids, bases and salts, electrolysis and electrolytic dissociation, sodium as a metallic element and its chief compounds, the sodium group of metals, the atmosphere, ammonia, nitric acid, the nitrogen family, the sulphur family, the calcium group, &c., ending with carbon and its inorganic compounds. In an appendix we find hints on the manipulation of glass, a list of apparatus required, a list of books for a teacher's library, a few numerical tables and two pages of logarithms.

It would not be difficult to find fault with the order of topics, and the chief objection would perhaps be to the early introduction of the theory of atoms and molecules and other theoretical matters. Mr. Torrey's order is probably not so good as some which have been elaborated in this country, but the method of the book in detail is so good that some faults of arrangement may be allowed to pass, and besides this it must be remembered that the book is not intended for children.

It is possible that on working through the book some faults of detail would be discovered. Many of the experiments described are novel in form, and some seem hardly likely to succeed. For example, on p. 98 an experiment is described, in which manganese dioxide is to be heated in a tube containing hydrogen chloride. The shrinkage of volume on opening the tube below a saturated solution of brine is said to represent the hydrogen which has disappeared. This is obviously wrong, and, practically speaking, the experiment is altogether an undesirable one.

In conclusion, it may be remarked that the book is unusually free from words or pedantries peculiar to America. An exception to this statement occurs on p. 7, where there is a reference to "the graduate being held in front of a dark surface to make the lines show more clearly." The graduate there means a glass vessel and not the careworn teacher. A. SMITHELLS.

A NEW EDITION OF WHITE'S "SELBORNE."

The Natural History and Antiquities of Selborne, and a Garden Kalendar. By the Rev. Gilbert White, M.A. Edited by R. Bowdler Sharpe, LL.D. Two vols. (London: S. T. Freemantle, 1900.)

IT will be as well to state exactly what is contained in these handsome but rather bulky volumes; the price is high (3*l.*), and purchasers will be glad to know what they are buying. In the first volume are the letters to

Pennant, *i.e.* the first part of the "Natural History of Selborne," freely interpolated with bracketed addenda from the originals in the British Museum, and including three or four letters of which White did not make use in preparing his book for the press. Then, pleasantly introduced by Dean Hole, and occupying more than 200 pages, come White's garden diaries from 1751 to 1771; of which a specimen, and enough to give an idea of White's personal activity as a gardener, was printed as an appendix to Bell's edition of the "Selborne" in 1877. The second volume contains the letters to Barrington, also with additions and interpolations from the originals, except in the case of the famous "monographies" of the Hirundinidæ, which were published separately by White in the *Philosophical Transactions*; the antiquities of Selborne are also here, and at the end we find a bibliography and a useful index, which appear to be sufficiently complete. Each volume is profusely illustrated. Mr. Keulemanns' drawings of birds are familiar and welcome; we have also a large number of fancy sketches by Mr. E. Sullivan, in most of which an imaginary Gilbert White is a prominent figure. Mr. Herbert Railton's head- and tail-pieces are, for the most part, delicate and attractive. As regards the notes, Dr. Sharpe's name is, of course, a sufficient guaıantee of the soundness of those on birds, and the only fault to be found with them is that they are occasionally a little wanting in succinctness and self-repression. Several of Dr. Sharpe's colleagues at the British Museum have provided him with useful notes relating to their departments of natural history, and a judicious selection has been made from the notes of previous editors, especially Bell and Harting.

From what has been said above, it will be seen that this is not really an edition of the book that White so carefully wrought into an artistic form, and that we all know and love. It is not pleasant to say it, but said it must be emphatically, that the liberties here taken with White's work have absolutely no literary justification, and have robbed it of much of that peculiar charm which, as Prof. Newton has well said in his admirable article on White in the "Dictionary of Biography," it is impossible to explain in words. What would have been White's own feelings if he had been forced to see in print the very portions of his letters which, with his own good sense and the respect of his age for publication, he had deliberately cut out, and the insertion of two hundred pages of his gardening notes between the letters to Pennant and those to Barrington? If it be argued that (as Dr. Sharpe seems to think) we learn something new about White himself by getting an idea of the original form of his letters and of the way in which he wrought his book out of them, the plain answer is that we already know all that is essential about him, and that one thing we know for certain is that he had a sense of literary form which has made his book immortal, and which should have secured for it more reverential handling than is to be found in these volumes. It might, indeed, be possibly justifiable to print the whole of the original letters as they left his hand; but not as an edition of the "Natural History of Selborne," which should always be allowed to stand exactly as his genius designed it. It will be the duty of future editors to see that none of the passages now interpolated are allowed to creep permanently into the text of the original work.

Dr. Sharpe's enthusiasm for his author is unquestionable, as may be seen from his brief but pleasant introduction to the first volume; so, too, is the labour that he has spent on his editorial task. But the perils of the editor of a classic are great, and enthusiasm alone will not teach him how to avoid them.

OUR BOOK SHELF.

The Romance of the Heavens. By A. W. Bickerton. Pp. 284. (London: Swan Sonnenschein and Co., Ltd., 1901.) 5*s.*

THE theory of constructive impact, of which a popular account is given in the present book, appears to have had its origin in an attempt to explain the phenomena of new stars by the grazing collision of two dark bodies. Hitherto the theory has not been hospitably received by astronomers, and the more elaborate exposition now presented will probably meet no better fate. The truth seems to be that in spite of his claim to have discovered numerous facts not known to "ordinary" astronomers, the author lacks familiarity with spectroscopic work and astronomical methods generally. He quite condemns himself by suggesting (p. 235) that more confirmatory evidence in the case of Nova Aurigæ was only wanting because astronomers, unguided by the theory, did not make "more liberal and careful observation." As a matter of fact, the most valuable records were photographic, and are still as much in evidence as during the visibility of the Nova, and the observations certainly cannot be interpreted as indicating the presence of three bodies of the kind required by the theory. The theory thus breaks down at the outset, and it would not be difficult to show the weakness of most of the "overwhelming" astronomical evidence on which depends its extension into collisions of nebulæ, clusters and cosmic systems by which it is argued that the existing forms and distribution of celestial bodies are completely explained. The merest possibilities are frequently magnified into certainties, as, for example, the occurrence of variable stars in pairs, and the preponderance of variability in double stars.

The resources of the theory appear to be unlimited. While one collision produces a new star, another results in a star cluster, another blows a planet into asteroids, and still another disperses a satellite into a ring such as that of Saturn.

We have not examined all the calculations which are given, but we may point out that the results arrived at for the separation of two stars of assumed distance and velocity (p. 58) are in each case six times too great.

The book is admirably written and is by no means without interest; but readers should be warned against mistaking the author's assertions for demonstrated truths.

Les Diastases et leurs Applications. By E. Pozzi-Escot Pp. 218. (Paris: Masson and Co., 1900.)

THIS little volume forms one of the series of Aide-Mémoire, some of which have been previously reviewed in this journal. Its modest preface disarms criticism. "Le lecteur ne devra pas chercher ici l'exposé de théories nouvelles; nous nous sommes contenté d'exposer les faits connus, de les relier l'un à l'autre et d'en tirer chaque fois qu'il y a eu lieu des conclusions légitimes." And further, "Forcément incomplet, nous espérons que notre travail (qui n'est point fait pour des biologistes, mais bien pour une collection destinée aux ingénieurs et aux chimistes), rendra néanmoins quelques services et

facilitera la diffusion de la notion des actions diastasiques, dans le domaine pratique."

The author fulfils the promise of his preface in giving a clear though brief exposition of the action of enzymes or *diastases*, special attention being directed to the experimental methods employed in the study of this subject and in their application to the brewery and the distillery.

The errors in spelling are numerous, and should be revised in a subsequent edition. Schunck appears as Schmuk; Marshall Ward figures as two persons, Marshall and Word; Croft Hill's individuality is also lost as Crop and Hill; O'Sullivan loses the O' and Lindner is spelt Linter, whilst the English name Heron and the German, Geduld, are converted into the French Héron and Gédulte.

Erythrozyme is written erythrozine, racemosus is spelt raciniosus, penicillium appears as penicellium and octosporus as octopodus.

An index would be a valuable addition. J. B. C.

Mongolia and the Mongols: Results of an Expedition to Mongolia in the Years 1892 *and* 1893. By A. Pozdnéeff. Vol. ii. 8vo. Pp. 516. Numerous photo-engravings (Russian, 1900).

THIS is the second of a series of volumes on Mongolia and its inhabitants which are being prepared by Dr. A. Pozdnéeff, and it contains the traveller's diaries during the second year of his journey, when South-eastern and Eastern Mongolia were visited. Starting from Pekin, Dr. Pozdnéeff went to Kalgan—the centre and depot for Russian trade with China—and thence to Kuku-khoto, or Gui-hua-chen, the next important commercial centre of Southern Mongolia. Returning to Kalgan, he visited that portion of Mongolia which lies on the eastern slopes of the Great Khingan—namely, the towns Fen-nin-sian and Zhe-ho, or Chen-de-fu, whence he went to Dolon-nor (Lama-miao). All these places are well known long since, but, speaking currently Mongolian, Dr. Pozdnéeff has learned much more about the trade in these towns than other travellers had before him, and having, moreover, in his capacity of learned Mongolist a free access to the Lamaite monasteries, he was enabled to collect a great amount of information about the inner life of Mongolia, various questions of worship, and especially about the antiquities preserved in the monasteries. Proceeding from Dolon-nor northwards and north-westwards, towards the Kerulen River, he visited the ruins of Kai-pin-fu—the thirteenth century capital of Khubilai-khan—and obtained there full casts and photographs of an interesting inscription dating from the fourteenth century. Another very interesting Tibetan and Mongolian inscription, dating from 1626, was copied in the same way at Tsagan-suburga, on the Shara-muren River. It may now be taken that this much-controversed spot was one of the five Lao or Kidan capitals—Lin-han-fu.

The remarks of the diary on the way across the Gobi are especially interesting, in that they give the exact limits between the Gobi proper and the zone of land which lies on the western slopes of the Great Khingan. This limit corresponds with a line which may be drawn on the Russian General Staff Map through the spots where the rivers shown on this map as flowing from the Khingan end in small lakes or marshes as they enter the Gobi. M. Pozdnéeff, who crossed the Gobi in June, fully confirms the view upon this region which begins now to prevail, namely, that it is not a desert, but a dry, rolling prairie. In fact, it has the same physical aspects as the dry "rolling prairies" of Canada at the approach of the Rocky Mountains.

The volume gains very much from the excellent photo-engravings with which it is illustrated. They give a good idea of the physical characters of these portions of Mongolia. P. K.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Gothic Vestiges in Central Asia.

I AM in thorough accord with the main principles indicated in Dr. A. C. Haddon's communication, which appeared in NATURE, vol. lxiii. p. 309 (January 24), more especially as to the eastern extension of a fair dolichocephalic race or races, at least as far east as the north-western frontiers of China. It has, however, always struck me, as a student of the ethnology of these districts, that sufficient attention has not been given to the geographical changes that have certainly occurred throughout the whole of Central Asia, and without which it appears impossible to understand such writers as Herodotus, Arrian and Ammianus Marcellinus. I claim no new discovery in suggesting, with Colonel Tchaikofsky (quoted by Schuyler, vol. i. p. 53), that during the Classical period the rivers Chu and Sary-su, instead of losing their waters in desert lakes, united at Perovsky with the Jaxartes, and flowed along the deserted bed, now known as the Jany Darya, joining finally the old Oxus and making their way along what is still known as the "Ancient Bed" of the Amu Darya to the Caspian. We thus arrive at a satisfactory explanation of the crossing of the "Araxes" by Cyrus, and his description of the homeland of the Massagetæ, whom we are then justified in associating ethnologically with the Getæ or Goths of other authors. This would throw light also on the position of Arrian's Alexandria Eschate, which I would identify with the modern Jizakh. This was situated on the Tanais, which seems to have been an overflow channel of the upper Jaxartes, leaving the main river at the bend below Khojend and flowing past Jizakh into the Taz Khane, whence it found its way into the Jany Darya.

We thus also get a satisfactory position for the Issedones, also a Gothic tribe ("West-Saetons"), east of whom were the Asii, Asiani or Pasiani, the Wusuns of the Chinese, who are described as "having blue (or green[1]) eyes, red beards and monkey-like faces"—alluding to their faces covered with tawny hair.

When, however, Dr. Haddon comes to his Chinese authorities several inaccuracies appear in his account. As Dr. Haddon himself is, apparently, not a student of that language, he has naturally been dependent on others, and the second-hand information with which he has been supplied is in the last degree misleading. He speaks, for instance, of the "Ssé or Sek (who are identified with the Sacæ)." I have a fair first-hand acquaintance with the older Chinese writers, and find myself unable to place these tribes. There were, at the period of which he speaks, Shuks, or rather Pa-shuks, in Szechwen; but there is no reason to connect them with any external tribe, nor have we a suggestion that they have ever migrated. There was a country—not a people—called Su-li, but the phonetic element here is Sulak, and we must identify the district with the Surak of the Bundahîsh, the country about the lower Jaxartes. The later writers, it is true, talk of a kingdom—not a people—called by Matwanlin Sse; but it is, apparently, the modern Sarakhs. The classical Sacæ, Scyths and Dahæ seem to be variations of the one word, and may be connected with the Tochari of Strabo the Tahia of the Chinese. I am, however, doubtful of Scyth or Sacæ being used by the Greeks in any sense as an ethnographic term; rather it applies to their stage of civilisation. We learn very little of these Tokhars from Chinese sources, but from Strabo we gather that they, in conjunction with the Wusuns and the Sakarauli (possibly the inhabitants of the Sarik-kol Pamir), bore down on Bactria and put an end to the Greek line of kings. About the same time the Yueh-ti, driven from their homes by the Hiung Nu (Turks), arrived in the country, and the two peoples seem to have more or less coalesced, and we find them a few years later living in apparent harmony, but occupying each its own side of the Oxus, the Yueh-ti apparently being the predominant race, or at least supplying the royal race. This is very different from the account given by his supposed authorities to Dr. Haddon. I have had the misfortune to have met with M. Drouin before, but now become acquainted with

[1] T'sing, the word used, means the colour of deep, pure water—grey, blue or green.

M. Ujfalvy for the first time. Apparently these authors have gathered their ideas from the French writers of the last century, whose knowledge of Chinese was confined to such works as the *B'ungkien Kangmu*, or even later works of about as much authority as Rollin's "Universal History."

A good deal of interest attaches to the Yueh-ti. Their original name was possibly Viddhal, and they seem to have had some prehistoric connection with the Yâdavas, who took part in the Indian immigration. There never was any doubt about their being the same people afterwards known to Greeks and Arabs as Ephthalitæ and Haithals respectively. With the Yueh-ti were associated in ancient Chinese legend the Mats, or Mat-su, apparently Maddhals, as in Indian lore Maddhu is associated with the Yâdavas, and this brings us to the later branch of the Yueh-ti, who in these authors by a strange mistake are called Yetha. Really the name in modern Chinese is Yenta, a very different sound. In the old language it was I'm-dat. Where the first syllable appears frequently doing duty as merely the initial *m*, Da, or rather Dat, where final *t* represents *l*, stands, then for Maddhal. This subtribe seems about the fifth century to have been settled in the neighbourhood of Bamian, and, except that it was less civilised than the other branches of the family, to have had little to distinguish it.

Both Greek and Chinese authors concur in describing these Ephthalites as being distinctly blond, with full beards, of a handsome type, and of lively manners. Menander calls the king under whose guidance they crossed the Hindukush Catulphus, at whose Teutonic aspect Colonel Yule expresses surprise. The Chinese, however, name him Kitolo, evidently the same word; most Chinese names consisting of only three words, the remainder is generally omitted in the transliteration of foreign names. Catulphus is, however, evidently the nearest Greek equivalent for Gothic Caedwulf. These allied peoples went amongst the Indians by the common appellation of Hunas, whence the alternative Greek name of White Huns, which has no connection whatever with that of the European Huns of the fourth century, whose swarthy complexions and hairless faces indicate a very different origin. These apparent Gothic connections are not confined to the Ephthalites, but occur throughout, the leader of the Scythians, ἐκ τῆς 'Ασίας, *i.e.* Wusuns, whom Alexander defeated outside Kyropolis, was, according to Arrian Satrakes, the Greek equivalent for Gothic Sietrich.

Of Dr. Haddon's Hoa, evidently derived from some mistaken French transliteration, I cannot even guess the origin. There is no such name to be found in the earlier and more authentic Chinese writers. Dr. Haddon is, however, quite correct in identifying the modern Chinese Yuan yoan, or Jwan Jwan, with the Avars of Gibbon.

Dr. Haddon expresses some surprise at the beardless faces of the later Huna kings; from the appearance of the king depicted on the coin, and its overhanging brows and prominent nose, he certainly did not belong to the smooth-faced races of the extreme north and east of Asia. So we may be sure that the bareness was artificial; it was probably the fashion of the time to shave.

With regard to the type of face and skull represented on the coin of Jayatu Mihirakula, I may remark that I met last night at dinner a gentleman of whom it might be called a portrait. I may describe him almost in Dr. Haddon's words as: Nose large, jaw powerful, neck fleshy, the occipital region of the head deficient, the vertex produced into a truncated cone. This remarkable shape was in his case quite natural. Moreover, with the exception of a moustache his face, as in the coin, was hairless. He had similar overhanging eyebrows, a like marked notch at the bridge of the nose, and an almost identically aquiline nose. His eyes, however, were not oblique, nor had he the slightest trace of the "Tatar," nor did he in any way approach the "Mongolian" type. The gentleman is, in fact, a Parsee of the highest type, polished and affable.

Shanghai, China, March 13. THOS. W. KINGSMILL.

Graphic Solution of the Cubics.

THE note by Mr. T. Hayashi, published in NATURE of March 28, suggests to me the following little historical remark. The method given by Mr. Hayashi for the cubics is due to Monge, "Correspondance sur l'École impériale polytechnique," par M. Hachette, vol. iii. p. 201; "Solution graphique de l'équation du troisième degré, $x^3-px+q=o$," par M. Monge.

"L'équation proposée résulte de l'élimination de y entre les deux $y=x^3$, $y=px+q$; l'une est le parabole cubique, . . . l'autre répresente une droite. . . . Ayant construit ces deux lignes, les abscisses x des points où elles se coupent, sont evidemment les racines de l'équation proposée."

Monge gives also a practical construction of the curve on a small sheet of paper *Nil sub sole novi!* G. VACCA.

Via Bogino, 4, Torino (Italy).

THE WORK OF THE NATIONAL ANTARCTIC EXPEDITION.

THE final programme of the scientific work of the National Antarctic Expedition had not been arranged at the date of my departure from England, as the Joint Committee of the Royal Society and the Royal Geographical Society had not issued its full instructions as to the route and plan to be adopted. A provisional summary may, however, be useful by calling forth suggestions while there is yet time to use them.

FIELD OF OPERATIONS.

It is, perhaps, hardly necessary to remark that it is not the object of the expedition to reach the South Pole, but to investigate the Antarctic regions; and though some of the problems cannot be solved unless the existing southern record is broken, the expedition is not being equipped especially for the attainment of much higher latitudes than have already been reached. Had that been one of the main objects of the expedition, either the ship might have been sent southward on a different line, or the expedition would have been provided with greater sledge-hauling power.

The operations of the British expedition are restricted to the half of the Antarctic area east of the meridians of 90° E. and 90° W., *i.e.* to the region south of Australia and the Pacific. The western half, including the region south of America, the Atlantic and Africa, is to be explored simultaneously by the German expedition under Prof. von Drygalski, by a Swedish expedition under Dr. O. Nordenskjold, and, it is hoped, also by a Scotch expedition under Mr. W. S. Bruce. This division of the field of work between the British and German expeditions was proposed at the Geographical Congress at Berlin, and has now been accepted on both sides and the plan of work arranged accordingly. So far as can be judged with our present knowledge, this plan, other things being equal, gives the German expedition the chance of the most striking geographical discoveries and the British expedition the opportunities for a richer harvest of scientific results.

The scientific work of the expedition is directed to cover as wide a field of research as is consistent with the essential objects of the expedition. Of these the object of primary importance is the study of terrestrial magnetism. It was upon the need for work upon this subject that the appeal to the Treasury for funds was based, and it was to enable the magnetic observations to be properly made that it was thought advisable to provide a new ship rather than adopt the less expensive course of adapting an existing whaler. A new ship—the *Discovery*—has accordingly been built by the Dundee Shipbuilding Co. She is a modified whaler of somewhat more than 1500 tons displacement, and with engines of 450 horse power.

The staff of the expedition is as follows:—The executive staff consists of Commander R. F. Scott, R.N., commander of the expedition; Lieutenant Albert Armitage, R.N.R., who distinguished himself in the Jackson-Harmsworth expedition to Franz-Josef Land, second in command and navigator; Lieutenants Royds, Barne and Shackleton; and Mr. Skelton, engineer. The civilian staff consists of Mr. T. V. Hodgson, formerly of the Plymouth Biological Laboratory and curator of the Plymouth Museum, biologist; Dr. R. Koettlitz, botanist; Mr.

Wm. Shackleton, of the Solar Physics Laboratory, physicist and astronomer; Dr. E. A. Wilson, zoologist and doctor to the land party; and the writer, who is director of the civilian staff and in command of the operations on shore. It is hoped that it may be possible to arrange for additional scientific assistance from volunteers who will accompany the ship in her cruises from Melbourne. Mr. G. Murray, F.R.S., who is editing the "Antarctic Manual," has kindly consented to act as deputy director of the civilian staff, and will superintend the scientific equipment in England, and probably accompany the *Discovery* as far as Melbourne.

Terrestrial Magnetism.

Considerations for the magnetic work have exercised a dominant influence in the plan of operations ordered by the Joint Committee. Magnetic work in the British field of operations has difficulties from which work in the western half of the Antarctic area is free; the horizontal magnetic force is exceptionally low, and great decimal variations in declination are frequent. These variations will, of course, affect the observations made on the *Discovery*, and unless this factor can be allowed for, it will be impossible to determine the proper magnetic elements for the ship's points of observation. Accordingly, the Magnetic Committee has declared it essential that there should be a station on shore in Southern Victoria Land to act as secondary magnetic base. It will be the first duty of the party landed at this station to secure a continuous magnetic record for a period of twelve months. For that purpose it will be supplied with a magnetograph, which will be under the special care of Mr. Shackleton; should the recording instrument fail, personal observations must be taken as frequently as possible. The records at this station will enable the observations taken during the magnetic survey at sea to be corrected for diurnal changes.

The Joint Committee has, therefore, decided that the *Discovery* shall proceed from her southern headquarters at Melbourne to Southern Victoria Land, where Captain Scott will land a party somewhere between McMurdo Bay and Wood Bay. The land party will consist of eight men, including Mr. Shackleton as physicist and Dr. E. A. Wilson as doctor and zoologist.

The Geographical Problems.

The selection of Southern Victoria Land, and the neighbourhood of Mounts Erebus and Terror, for the site of the land station is recommended by geographical as well as by magnetic considerations. Topographical exploration is the second important branch of the work of the expedition, for it is necessary as a base for much of the other work; and it was probably interest in this subject that inspired Colonel Longstaff's munificent donation, which brought the expedition within the range of practical politics.

Fortunately, sufficient is now known of the geography of the eastern half of the Antarctic area to enable a definite plan of operations to be arranged. We need not, like Cook, strike blindly into the Antarctic, knowing no more of one line than of another. There are two main geographical problems in the British field of work. The first problem is whether the known lands to the south of Australia—Victoria Land, Wilkes Land, Adelie Land, Geikie Land, Newnes Land, Termination Land, &c.—are all part of one great continent or are members of an Antarctic archipelago. The classical and mediæval geographers accepted the existence of an Antarctic continent, belief in which is now supported by Suess's principles of geographical distribution.

Australia, as Suess has explained to us, consists of a great plateau bounded to the north and east by the important tectonic line which passes through New Guinea, New Caledonia and New Zealand. Ritter has therefore very plausibly suggested that the volcanic chain that forms the eastern face of Victoria Land is the continuation of the New Zealand volcanic line, and that the coast of Wilkes Land is a southern extension of the Australian plateau.

This hypothesis, advanced at first on general considerations, is consistent with all available geological evidence. The specimens collected by Wilkes and the boulders dredged by the *Challenger* and the *Valdivia* include archæan and sedimentary rocks similar to those of Southern Australia; and Mr. Borchgrevink has brought home a collection of specimens which have been kindly shown to me by Mr. Prior, and are practically identical with some of the Lower Palæozoic rocks of Victoria.

The rocks of the eastern face of Victoria Land have been described by Teall and David; and their identifications show that the volcanic rocks resemble those of New Zealand.[1]

There is, therefore, little doubt that Antarctica is *geologically* a continent, consisting of a western plateau, composed of archæan and sedimentary rocks like those of Australia, and of an eastern volcanic chain. But whether Antarctica is still a continent *geographically* is less certain; and this question can only be conclusively settled by a survey. Land journeys westward and southward from Mount Erebus ought to settle this problem.

The volcanic line of Victoria Land runs north and south for some 8 or 10 degrees of latitude; at 77° S. lat. the coast and the volcanic chain bends abruptly to the east. The discovery of their eastward continuation is the second main geographical problem to be settled in the British half of the Antarctic area.

Ross sailed to the east for some 30 degrees, along the face of the "Ice-Barrier"; and though the origin of the barrier-ice is not yet certainly known, it has probably been formed on land. Ross has recorded a "strong appearance of land" beyond the eastern end of the barrier (160° W.), and the barrier may be roughly parallel to the edge of a land line connecting the Parry Mountains and Ross's "apparent land."

Beyond this point is a gap until, 70° further to the east, we come to Graham's Land. In the intermediate area there has been no direct record of any large land area that would connect Graham's Land and Victoria Land. But Cook's description of his view from his turning-point at 137° W. 67° S. is suggestive of a land with peaks rising through an ice-sheet rather than of a number of icebergs frozen into pack-ice. Cook, however, clearly interpreted it as the latter. The indirect evidence as to the geographical character of the line between Graham's Land and Mounts Erebus and Terror is more important. It is based on Suess's law of coast distribution.

The Pacific Ocean is bounded by coasts the trend of which is determined by mountain ranges which run parallel to the shore. This rule holds in Eastern Australia, Eastern Asia, Malaysia, and throughout the western coast of America with an unimportant exception in Central America. The remaining coasts of the world are on the Atlantic type, in which the coast lines are not determined by the trend of long, folded mountain chains; the mountain ranges are cut transversely or obliquely, and the coasts are mainly formed of plateaux and coast plains. Ritter has made the probable suggestion that the low coast of Wilkes Land is on the Atlantic type, and the high mountain chain of Victoria Land is on the Pacific type. Graham's Land has a characteristic Pacific coast; and when we remember the persistence of that type round the whole of the

[1] The continuation of the tectonic line that crosses Southern New Zealand obliquely to the main New Zealand line has not yet been determined, and it may be found to play an important part in the southern shore of the Pacific.

known shores of the Pacific, it appears not improbable that the Southern Pacific is bounded by a coast of the same type. If so, we should expect the Parry Mountains and Graham's Land to be connected by a series of mountain bows, the curves convex to the north, and with at least the traces of island festoons.

In that case the great tectonic lines which bound the Pacific to east and west are connected across the Antarctic area; and if that can be proved the unity of the great Pacific depression will be completely established.

That this South Pacific coast line can be discovered and surveyed by the expedition is improbable; when we remember the limited extent of the areas explored by Arctic expeditions, one ship cannot be expected to investigate half the Antarctic zone in the course of sixteen or eighteen months.

Considerable indirect evidence bearing on this problem may, however, be obtained; information as to the geology of Dougherty Island, and an extensive collection of bottom deposits along the edge of the ice-pack in the Southern Pacific, would no doubt throw much light on the geographical character of the area to the south. The expedition, moreover, should secure information as to the oceanic circulation and ice-drift which will enable a carefully-thought-out attack on this quadrant to be made. Our knowledge of the Ross quadrant, as Sir Clements Markham has called it, is so limited that it gives us no trustworthy suggestion as to the best lines of entry. And the Joint Committee appears to have accepted the principle that the expedition should work where present knowledge gives most guidance as to profitable lines of discovery and research.

Sketch map of Antarctic area, showing probable connection of the tectonic lines of New Zealand and the Andes through Victoria and Graham Lands. The arrows indicate probable directions of ice movement. The upper half of the map includes the British field of work; the lower half is that assigned to the German expedition.

GEODETIC WORK.

The principal geodetic work of the expedition will be the continuation of the line of gravity determinations that has now been carried from California across the Pacific to Sydney, and thence through Melbourne, Tasmania and New Zealand. This work will be done by a new set of three of the Ellery half-seconds pendulums, which, thanks to Mr. Baracchi, have been made for loan to the expedition by the Victorian Government. The pendulum results will be checked by the use of two of the gravity torsion balances designed by Profs. Threlfall and Pollock.

If it be possible to land for a couple of days at Cape Adare, gravity determinations should be made there as well as at the land station in Southern Victoria Land.

SEISMOLOGY.

At this station a seismographic observatory will also be established. A Milne seismometer of the British Association pattern and a Ewing's duplex recorder are both to be installed.

METEOROLOGY.

A station on shore that will give a complete year's observations is necessary for the meteorological work as well as for the magnetic. The meteorological equipment will be exceptionally complete, thanks to the Admiralty, the Meteorological Council, Dr. R. H. Scott, Dr. H. R. Mill and Mr. W. N. Shaw. Recording instruments, including barographs, thermographs and hygrographs, will be established and checked by four-hourly direct observations; in case of the collapse of the recording instruments, observations will be taken every two hours, and during part of the year it will probably be possible to take them every hour.

As the observatory will probably be near the face of a lofty mountain range, the atmospheric conditions may be abnormal. To ascertain the conditions of the free air, it is proposed to fly kites with meteorographs. The Hargreaves kites, as modified at Dr. Rotch's observatory at Blue Hill, will be used.

The special meteorological problem to be determined by the combined expeditions is the existence of the hypothetical anticyclone over the South Pole. The careful meteorological observations made by Mr. Bernacchi during the Borchgrevink expedition have given almost a complete year's record for Cape Adare; they have shown the prevalence there of south-easterly winds which were unexpectedly warm, and are apparently due to a northern air-current being forced to sea-level and to return northward in the area to the south-east of Cape Adare.

OCEANOGRAPHY.

The expedition is also being generously equipped for oceanographic work, as the Admiralty, thanks to Sir William Wharton, is supplying the whole of the material. The first branch of this work will be the continuation of the contributions of former expeditions to the contour of the Antarctic ocean floor; and it is hoped that, in addition to complete series of soundings in special areas, new lines of soundings will cover a wide area around the edge of the ice-pack. The study of the bottom deposits collected during the soundings will be of especial interest, as bearing on the range and structure of the Antarctic lands; and their evidence will be supplemented by dredging for boulders with a special bucket-dredge.

The determination of the oceanic circulation as shown by the varying temperature, salinity, specific gravity and refractive index of the sea water will be the most arduous part of the oceanographic work. Owing to the importance and difficulty of this research, independent methods will be used concurrently. In the aërial temperature determinations we hope, like the German expedition, to have the assistance of a platinum thermometer, arrangements for which are being made by Prof. Ayrton. The mechanical difficulties in the management of the cable renders it indispensable that a full equipment of mercurial thermometers shall be carried; but electric thermometry has reached a stage at which we may hope that in determining temperatures under the great pressures of oceanic depths we need not rely on a method dependent on volume.

The tidal work will be done at the shore station, where a tide pole will be erected and observations taken for at least three months. Tidal observations on the Antarctic shores, according to Prof. G. H. Darwin, "would be of especially great interest, since this is the only region of the earth in which the water is uninterrupted by land."

Biology.

The biological work of the expedition will be mainly at sea; for the ancient maxim that "Nature loves life" does not appear to apply to the Antarctic lands. The main biological duty of the expedition is to make as extensive a collection of the fauna and flora of the Antarctic Ocean as the ship's storage will admit. As the German expedition proposes to limit its dredging to work of less than a thousand fathoms, it is all the more advisable that the *Discovery* shall dredge in the deep basins as well as in the shallower seas; for though the latter may be richer in individuals, they will probably be comparatively poor in species; whereas the deeper parts of the Antarctic will probably be rich in novelties, and will afford the most valuable materials for the solution of the problem of bipolarity.

Sir John Murray's suggestive views as to the relations of the Arctic and Antarctic faunas are too well known to need re-statement here. His theory is based in the main on the *Challenger* collections, and much further material is required before it can be settled whether the resemblances between the Arctic and Antarctic faunas are homoplastic or homogenetic.

In the zoological work Mr. Hodgson will devote his attention mainly to the invertebrates, and Dr. Wilson to the vertebrates. Mr. Koettlitz will be the botanist of the expedition, and will study especially the phyto-plankton and bacteria of the Antarctic seas.

Geology.

The Antarctic continent being often described as buried completely under a pall of ice and snow is not regarded as a hopeful field for geological work. But though the conditions may be unfavourable, the geological problems of the Antarctic are exceptionally interesting.

Stratigraphically we may expect Wilkes Land to show us a continuation of the rocks of the Australian plateau; and as part of the South Australian coast is at least of Lower Cainozoic age, we may hope for marine deposits of the same age on the northern face of the Antarctic lands. That Palæozoic sediments and limestones occur there is now certain, and they ought to yield fossils if the right zones are exposed. Palæozoic fossils will be of value, but the discovery of Cainozoic land fossils would be of far wider interest. The Biological Committee has called attention to the importance of geological work on the Antarctic lands, and that alone can settle the problems of zoological distribution in South America, South Africa and Australia during Cainozoic times.

It is, however, the way with fossils to occur in soft beds which have been worn into hollows and buried in a country that has been roughly used by the elements. Hence the palæontological results may be meagre, and the palæontological and physical branches of geology will probably gain most from a preliminary traverse.

The glacial work, including the character and distribution of the different ice-agents, the relations of the valley glaciers to the main ice-sheets, the physics of glacier ice, and especially the relation of shearing planes to the orientation of the ice-grains; the distribution of morainic and intraglacial material and the rate of flow of the glaciers are all problems which it is recommended that the members of the expedition should study. Prof. von Drygalski's work in Greenland has called renewed attention to the theory that glacial flow is due to repeated melting and regelation; whereas Müggé's experiments on the shearing planes in ice support the view that plasticity is an essential property of ice. Further experiments on this question will be conducted during the winter on blocks of glacier ice.

The nature of the inland ice is a problem that can only be directly solved by sledge journeys; and if sufficient dog transport be provided, it is hoped that two sledge parties will start from the land station in the early spring. One party will naturally strike westward to cross the mountain range, and the other to the south. How far these parties may be expected to penetrate into the interior will depend on the amount of sledge-hauling power available and on the structure of the country. The westward party would, it is hoped, cross the volcanic mountain chain to the plateau that probably lies beyond it. If the station be established at McMurdo Bay, the southern party ought also to penetrate beyond the coast ranges and discover what lies between the Parry Mountains and the South Pole. On the hypothesis that the South Pacific coast is on the Pacific type of coast structure, then we may expect that the greatest elevations on the Antarctic Lands will lie along the Graham's Land-Victoria Land line, and will be near the sea. To the south of the main mountain range there may be an undulating ice-covered region descending slowly across the Pole to the shore of the Weddell Sea. The main ice-drainages would then be not from the Pole radially in all directions; the ice-shed would run along the Pacific shore with a short steep northern face and a long gradual slope southward to the Pole and across it northward to the Atlantic. That the main ice discharge from the Antarctic lands is into the Weddell Sea is probable, since the biggest of the Antarctic icebergs, including those described as sixty miles long and forty miles broad, are apparently discharged from the Weddell Sea. As these bergs are discharged intermittently, it has been suggested from earthquake action, the Weddell Sea route to the south probably varies greatly in different years, and success in penetrating to the coast-line there might yield comparatively barren results, for the ship would probably be stopped against the stranded border of a vast ice-sheet, and find neither land for a shore station nor harbour for a ship; and travel over the ice-sheet would be unprofitable. As Sir Clements Markham has expressed it, "the Weddell route offers the minimum of results with the maximum of risks."

The Erebus and Terror region, on the other hand, offers a known base of operations, for a landing has already been effected on its shore. And the available geographical, geological and meteorological data all point to it, as in the critical part of the Antarctic lands.

J. W. Gregory.

PRACTICAL PROBLEMS IN THE METALLOGRAPHY OF STEEL.

SINCE Sorby in 1864 established the all-important fact that steel must be regarded as a crystallised igneous rock, his work has been greatly expanded by the international labours of many able microscopists. Much of the work done, however, has been of academical rather than of practical interest, and busy steel works' metallurgists, appalled by the rapid growth of constituents ending in "ite," of "eutectics" and of solid solutions of carbon or carbides in unisolated allotropic modifications of iron, are already beginning to ask themselves the question, Is micrographic analysis going to be of any real use to us, and, if so, in what direction? The present article is an attempt to very briefly answer the above questions.

The theory prevalent a quarter of a century ago that steels of identical chemical composition would necessarily have the same mechanical properties has long since been discarded. But perhaps steel metallurgists have not yet fully realised the disconcerting fact that steel of excellent chemical composition, giving highly satisfactory mechanical tests, may nevertheless utterly fail in use, possibly with disastrous results. In other words, a ductile steel which bends double cold without any sign of flaw or failure may, under the influence of vibration, snap like a piece of glass, though only subjected to mechanical stresses well below its elastic limit.

In connection with the materials of construction used for high-speed engines, both land and marine, it is at the present time a problem of paramount importance for the scientific steel metallurgist to determine the cause of the sudden infidelity of steel (or wrought iron) under vibration.

Data in the writer's possession prove beyond all doubt that steel giving splendid chemical and mechanical tests may rupture under vibration possibly in a few hours or perhaps only after the lapse of twenty years.

There is little doubt that in many cases the microscope is capable of giving warning of the dangerous character of a steel, chemically, and apparently mechanically, safe. To intelligibly describe the structures of safe and dangerous steels it is necessary to consider:

(*a*) The micrographic constituents of structural steel.

(*b*) The molecular migrations of these constituents when at a red heat the metallic mass is in a semi-plastic state.

To put the case concretely, the chemical constituents of a typical rail may (in addition to iron) be approximately taken as carbon 0·40, silicon 0·05, manganese 0·90, sulphur 0·06, phosphorus 0·06 per cent., together with small percentages of arsenic and copper. The micrographic constituents of such a steel are:

(1) The pale, simple constituent ferrite (in this case somewhat impure iron).

(2) The dark etching compound constituent pearlite, consisting of mixed granules of iron and of a double carbide of iron and manganese.

(3) The dove-grey simple constituent sulphide of manganese, MnS.

It is important to remember that in manganiferous steels the foregoing constituents are only completely differentiated visually on slow cooling from a full red heat, a fact which at once introduces the vital question of the migration of constituents. Speaking broadly, it may be said that sulphide of manganese is not, under working conditions, capable of migration to any appreciable extent. Thus it remains to consider only the migrations of the ferrite and pearlite.

The movements of these constituents on heating may be termed "diffusion," and their movements on cooling "segregation."

On heating the typical steel specified to about 700° C. the compound constituent pearlite is converted, with absorption of heat, into the simple constituent, martensite, at Osmond's point A_c1. Then, passing through Osmond's points A_c2–3, the constituents ferrite and martensite diffuse one into the other till, at about 800° C., molecular equilibrium is eventually established.

If, however, the steel be cooled very slowly, the molecules of martensite and of ferrite will perfectly segregate in the respective proportions of about 45 and 55 per cent. Then at Ar. 1, about 640° C., the martensite will decompose into the compound constituent pearlite, which, owing to the presence of manganese, will be granular and not laminated. On the other hand, if the steel is somewhat quickly cooled in air, the segregation of the constituents will be imperfect and the apparent proportion of pearlite relatively large, because, owing to the influence of the manganese present, the phenomenon of constitutional segregation is retarded.

As a matter of fact, the apparently large area of dark pearlite is really an extremely intimate mixture of true pearlite and unsegregated ferrite.

The writer is aware that these statements may provoke theoretical opposition, but they nevertheless describe the

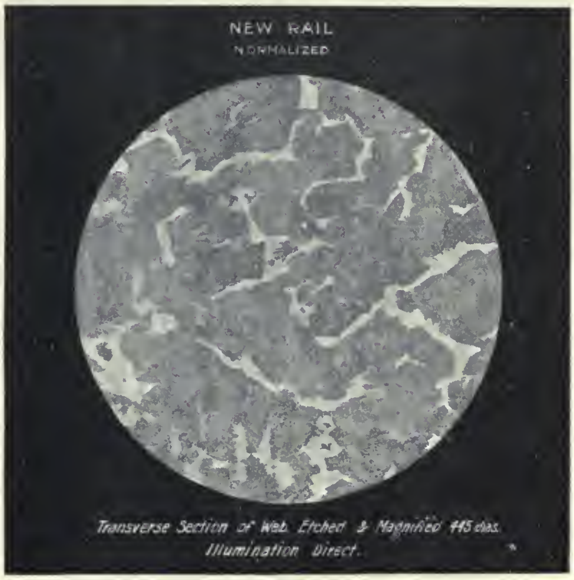

FIG. 1.—Size of original drawing, six inches; magnification, 445 diameters. The magnification here represented is about 166 diameters.

observed facts, and by these, and not by theories, the practical metallurgist must be guided.

The micrograph Fig. 1 shows the transverse section of a rail web re-heated to 900° C. and allowed to cool in air; and this web exhibits the same structure in all the three planes of section presently to be referred to.

The micrograph Fig. 2 shows the structure when the rail was slowly cooled in the re-heating furnace during a period of 50 hours.

In Fig. 1 the pale ferrite has imperfectly segregated in the form of ragged and broken cell walls imperfectly environing cells of pearlite mixed with unsegregated ferrite.

In Fig. 2 the pale ferrite and dark granular pearlite have perfectly segregated mainly in the form of thick, alternating laminæ. The structure last named must be regarded as highly dangerous, because under vibration the adhesion between the constituents is liable to gradually loosen and finally to be destroyed. Nevertheless, mechanical tests would initially reveal little difference in the ductility of the two pieces of rail.

The foregoing facts give the clue to the direction in which the steel microscopist must look for danger with reference to rupture under vibration.

In a brief article it is difficult to do more than give suggestions, but it is necessary to point out that the majority of published micrographs exhibit a single plane of transverse section. Such representation can give only a very partial knowledge of what may be termed the solid geometry of steel.

To determine this it is necessary, in rolled metals, to make three micrographs in three planes of section at right-angles to each other, namely (*a*) a tranverse section, (*b*) a longitudinal horizontal section, (*c*) a longitudinal vertical section. From these the exact form in which any constituent exists in the mass can be determined.

As an example, the case of the constituent sulphide of manganese may be taken. It must be remembered that 0·09 per cent. by weight of sulphur corresponds to no less than 0·5 per cent. by volume of manganese sulphide, a very appreciable amount for a micro-constituent.

In the original ingot during solidification and cooling the sulphide segregates into roughly globular masses

FIG. 2.—Size of original drawing, six inches; magnification, 112 diameters. The magnification here represented is about 42 diameters.

On reheating the ingot for rolling, the sulphide liquefies and the liquid globules are elongated in the direction of the rolling, and necessarily to some extent in a line at right-angles to that direction. Hence in a steel plate, the sulphide may present in the three planes of section above specified the appearances exhibited in Fig. 3, which shows that the sulphide is distributed throughout the steel in the form of irregular, oval laminæ.

It will be obvious that the evil mechanical influence of this constituent will be at its minimum along the length of the plate, somewhat greater across the plate, and at its dangerous maximum through the thickness of the plate.

Perhaps an obstacle to the development of steel works' metallography, even greater than the terror inspired by an unnecessarily complicated nomenclature, is the apparatus, time, care and special reagents supposed to be necessary to obtain, by polishing and etching, a good micro-section. In the advocacy of this view no one has been more earnest than the writer, and for research purposes it is doubtless sound. But for works' purposes, in connection with most steels, it must be confessed that such necessity has been exaggerated.

The writer has, therefore, pleasure in withdrawing his former view owing to experience having proved that by a very much simplified modification of method, a micro-section may be placed upon the stage for examination in five minutes after it leaves the dead smooth file in the machine shop. This process, which entirely does away with elaborate polishing apparatus or special etching reagents, is as follows:

Take two pieces of hard wood, 12″×9″×1″, planed dead smooth on one side; then by means of liquid glue evenly attach to the smooth faces two sheets of the London Emery Works Co.'s Atlas cloth, No. 0. Allow the glue to set under strong pressure. Next, by means of a smooth piece of steel, rub off from one of the blocks as much as possible of the detachable emery. This is No. 2 block, the other, necessarily, No. 1 block.

The steel section, say $\frac{1}{8}$ inch thick and $\frac{1}{2}$ inch diameter, is rubbed for one minute on No. 1 block, the motion being straight and not circular; then, for the same time and in the same manner, rub on No. 2 block. Next place the bright but visibly scratched section in a glass etching dish 3″×1″×$\frac{1}{2}$″, and cover the steel with nitric acid, sp. gr. 1·20.

Watch closely, until in a few seconds the evolved gases adhering to the section change from pale to deep brown and effervescence ensues. Then, under the tap, quickly wash away the acid and for a minute immerse

FIG. 3.

the piece in a second dish containing rectified methylated spirits. Dry the section by pressing it several times on a soft folded linen handkerchief, when it will be ready for examination. The structure will be clearly exhibited, the innumerable fine scratches visible before etching having virtually vanished.

The micrographs illustrating this article were prepared in a very few minutes by the above process, and have been accurately reproduced by Mr. F. Ibbotson. The writer hopes that this simple and rapid method may help to stimulate in steel works' practice a more extensive study of metallography.

J. O. ARNOLD.

THE WORK OF THE REICHSANSTALT.

A THICK quarto volume of nearly five hundred pages[1] gives a full account of the recent scientific researches of the Reichsanstalt. It is impossible, and perhaps not very useful, to attempt in the brief compass of a notice any full description of these varied investigations. All who are interested in physical measurement know that when a paper on any subject is issued from the Reichsanstalt it must be studied by any workers who come after.

In some respects the volume is sad reading to an Englishman. Problems which originated in England have in too many cases received their final solution from the researches of one or more of the distinguished band of workers gathered round the Director, Prof. Kohlrausch.

The volume opens with Dr. Thiessen's research on the

[1] Wissenschaftliche Abhandlungen der Physikalisch Technischen Reichsanstalt. Band iii. Pp. 477. (Berlin: J. Springer, 1900).

thermal expansion of water between 0° and 40°. To this problem Regnault's method of measuring the thermal expansion of mercury is applied, with suitable modifications. Elaborate precautions are taken to secure that the temperature of each of the two balancing columns should be the same throughout, but the difficulty of the measurement lies in determining the difference in level of the ends of these two columns, and Dr. Thiessen's apparatus designed for this purpose proved in his hands most successful. It may perhaps be useful to give the table of the density of water at various temperatures under atmospheric pressure, assuming the density at 4° C. to be unity.

t.	Density according to Thiessen.	Difference from Chappuis' values.
0°	·9998676	− 2
10	·9997270	+ 2
15	·9991263	+22
20	·9982299	+29
25	·9970715	+11
30	·9956736	+19
35	·9940576	+47
40	·9922418	+43

In the third column are given the differences between Chappuis' values found in 1897 and those obtained by Thiessen.

It will be observed that throughout they are very small; indeed a closer examination shows that from 0° to 12° the differences only amount to one or two units in the seventh figure. Chappuis' measurements, it may be mentioned, were made by aid of a dilatometer of platinum-iridium, and involve a knowledge of the thermal expansion of that substance.

In a second paper Dr. Thiessen applies to the same apparatus for measuring the difference of height of two columns to the determination of the pressure of saturated water vapour. The value found for this quantity at 0° C. is 4·579 mm. of mercury, with a probable error of ·001 mm.

Another paper which should have many readers is that by Profs. Jæger and Kahle, on the mercury standards of resistance. This is a continuation of Dr. Jæger's paper in the second volume of the *Transactions* of the Reichsanstalt. A very full description is given of the work of constructing the standards and determining by calibration their resistance in terms of the ohm as defined legally, viz., the resistance of a column of mercury at 0° C., 106·3 centimetres in length and 14·4521 grammes in mass. The tubes were then compared electrically among themselves, and also with the manganin standards of the Reichsanstalt. For this purpose four manganin coils are used. The mean value of the resistance of these four coils at 18° C., as determined from the original tubes calibrated in 1892, was found to be 1·004582, and from the new tubes calibrated in 1897, 1·004578. Changes amounting to about ·00002 were observed in some of the manganin coils during the period of observation.

Dr. Kohlrausch himself contributes a very important paper on the resistance of aqueous solutions of the chlorides and nitrates of the alkalis.

This is followed by a comparison of thermometers made of various kinds of glass, with a further intercomparison of the standard thermometers of the institution.

As regards the depression of the freezing point, the former observations of Wiebe and others are confirmed; it increases for the older kinds of glass, according to a more or less parabolic law, with the temperature to which the thermometer has been raised; while, as before, it is clearly shown that the depression is much greater in glasses containing both soda and potash than it is in glasses which contain either soda or potash only.

Perhaps, however, the most striking results in the volume are those contained in a paper by Drs. Jæger and Diesselhorst on the thermal and electric conductivities, the specific heats and thermo-electromotive forces of certain metals.

When a current passes through a conductor it is heated; when, however, a stationary state is reached, the distribution both of current and of temperature does not change with the time. The conditions for this involve the ratio between the electric and thermal conductivities of the material, and Kohlrausch showed how this ratio might be readily determined by observations on the temperature and potential of three points of a conductor carrying a constant current, provided the ends of the conductor be maintained at a constant temperature.

The theory and the experimental details are both fully given in the paper; the temperatures were determined by the aid of very small thermal elements. The bars of metal experimented on were in most cases about 27 cm. in length, and from 1 to 2 cm. in diameter. The metals examined included gold, silver and platinum, while bars of rhodium and iridium, weighing respectively about ·75 and 1·33 kilogrammes, were prepared by Herr Heræus, but could not be used because of their extreme hardness.

In addition to determining the electric and thermal conductivities at 18° and at 100° C., the specific heats at these two temperatures and their thermo-electromotive forces as against copper were also determined.

Attention had been called by Wiedemann and Franz, in 1853, to the fact that the electrical and thermal conductivities of many substances are approximately proportional, and L. Lorenz, in 1881, had shown that the ratio of the thermal to the electric conductivities at various temperatures is approximately proportional to the absolute temperature. The experiments here described enable us to test these laws. The ratio is shown not to be accurately a constant, it varies in the case of the materials tested, excluding constantan, from 636 for aluminium to 964 for bismuth, but in far the greater number of cases its value lies between 670 and 800, a striking result when it is recollected that the electric conductivities vary between 5 and 60. The temperature coefficient of the ratio ranges, omitting bismuth and one or two high resistance alloys such as constantan and manganin, from ·034 to ·046; if the Lorenz law were true it would be ·0366 in all cases.

Sufficient, perhaps, has been said to indicate the importance of the volume and the high value of the researches which continue to be carried on at the Reichsanstalt.

MEDIÆVAL NATURAL HISTORY IN POLAND.[1]

THERE are few more interesting occupations than to trace the growth of scientific knowledge in the field of natural history. We are heirs of the labours of our forefathers, who were fain to struggle through obscure and devious paths to build up the mass of information on these subjects with which we are furnished. We find them living in a wonderland of the strangest credulity and superstition, and their errors have only gradually disappeared in the process of scientific investigation. With herbs, animals and precious stones were connected the wildest theories. Folk-lore played a busy part; the mandrake uttered groans when it was pulled up; the toad had a jewel in its head; the barnacle was half herb and half animal, and the barometz was a lamb which partook of a vegetable

[1] "Symbola ad historiam naturalem medii ævi. Sredniowieczna Historya Naturalna. Systematyczne zestawienie roslin, zwierzat, mineralow oraz wszystkich innego rodzaju, lekow prostych, uzywanych w Polsce od xii do xvi w. przez Jozefa Rostafinskiego." ("Mediæval Natural History. A systematic account of the plants, animals, minerals and all kinds of simple herbs known in Poland from the twelfth to the sixteenth century." By Joseph Rostafinski. (Cracow: University Press.)

nature. These beliefs have slowly died out, but Sir Thomas Browne, who lived so recently as the latter part of the seventeenth century, in his *Pseudodoxia Epidemica* wrote a book against the delusions of his countrymen, himself believing in many absurdities. The medicinal uses to which animals and herbs were applied strike us forcibly in these modern times. The scientific medical man of the nineteenth century was to be slowly evolved out of the medicine-man and conjurer. Nor are the two last entirely gone; they still may be found in the less civilised parts of Europe and in the more unfrequented nooks of our own country. We have no space to enumerate here the old works treating of popular therapeutics in England, such as the Anglo-Saxon medical books edited by the late Oswald Cockayne, in 1864, under the fantastic title, "Leechcraft and Wort-cunning." The late Mr. Mowat, of Oxford, published two contributions on the subject in his *Alphita* and *Sinonoma Bartholomaei*. Many other works could be cited in English literature, but the immediate object of our article is to call the attention of our readers to the two volumes which have appeared from the pen of Mr. Joseph Rostafinski, professor of botany in the University of Cracow, and the title of which is given at the foot of p. 615. Prof. Rostafinski has furnished lists of the names of plants, animals, minerals and various kinds of herbs which were known in Poland from the twelfth to the sixteenth century. The greater part of these names are preserved in manuscript vocabularies in the libraries of Cracow (especially the so-called Jagiellon), Lemberg, Prague and St. Petersburg. Some of these vocabularies first became known in the pages of the Warsaw review, *Prace Filologiczne*, to which they were contributed by Prof. Brückner, of Berlin, one of the foremost Polish scholars.

For the botanist and student of natural history, these volumes have much value. Prof. Rostafinski catalogues the names of the plants, &c., upon a carefully-arranged system; compares the different names under which they are found, and gives us the Latin equivalents, which will help us in our search for them. He shows us where information has been gathered from Pliny and Dioscorides. His notes abound with folk-lore, and most people know how interesting folk-medicine is. Thus, of the herb koniochrom (*Hippocrepis comosa, L.*) we are told that it has this name (lit., making a horse lame) because if a horse treads upon it his shoe will fall off. The Slavonic appellation for the linden, or lime-tree, is lipa, and comes up in the original Slavonic name for Leipzig, Lipsk. On p. 443, vol. i., we get interesting details of the auerochs, of which a picture is given in Hartknoch's quaint old book on Prussia. It has now been almost exterminated, and is only found in some forests of Lithuania, where it is preserved for the Emperor's hunting. It is singular that in the sixteenth century camels were used in Poland; thus we find them employed in the time of Sigismund Augustus, when that monarch was journeying from Cracow to Wilno. The Slavonic name for camel is derived from the Gothic word ulbandus, which is really a very ancient adaptation of the Greek ἐλέφας.

One of the most curious parts of this interesting book is where the writer deals with the fabulous animals, basilisks, &c. The folk-lore connected with these is abundant. We are reminded of the work of our own countryman, Topsell. In fact, we have a good account of the flora, fauna and minerals, how they were called and what was known of them in Poland during the Middle Ages. Although the scope of the work is in a way limited to Poland, yet, as the author says in his introduction, which appears in Latin as well as in Polish, the book will be serviceable for north Europe generally. There is in reality a great unanimity in many of these legends about plants and animals. Pliny leads off, we may say, in his "Natural History," which was the great storehouse during the Middle Ages for folk-lore of all kinds. We must not forget, also, Bartholomæus' "De Proprietatibus Rerum," *a.* 1400. The Slavonic riches are being gradually collected; much has been already done in Russian, and the late Mr. Ralston made use of it in his books of Russian folk-songs and Russian folk-tales. The *Sbornik*, or *Miscellany*, published yearly by the Bulgarian Government, generally devotes a section of each new volume to these popular traditions. In England we have no special organ, except it be the *Folk-lore Journal*; our popular superstitions must be gathered from the miscellaneous pages of *Notes and Queries* and such books as "Gerard's Herbal." No little light is afforded by the curious medical works published in the sixteenth and seventeenth centuries, among which may be expressly mentioned the "Breuyary" of Andrew Borde and the choicely quaint work of Dr. Tobias Venner. In the life of Seth Ward, by Dr. Walter Pope, some extraordinary tales are told of a surgical operator of that time, and also in Aubrey's Lives.

In all countries the popular names given to plants may be said to be richly significant, and therefore not only the man of science, but the philologist may find much material in Prof. Rostafinski's volumes.

INTERNATIONAL ASSOCIATION OF ACADEMIES.

The meetings of the International Association of Acadamies were concluded last Saturday, when it was determined unanimously that the next Congress should be held in London in 1904. Although the *Comptes rendus* of the various meetings have not yet been published, it is known that much useful work has been accomplished. Nothing could exceed the cordiality of the reception accorded to the foreign delegates by the French authorities and their scientific *confrères*. After the final meeting on Saturday, the delegates were received by the President of the Republic and Madame Loubet, and later in the day they attended a dinner and concert given in their honour at the Hôtel de Ville.

NOTES.

As already announced, a complimentary dinner to Sir Archibald Geikie will be given next Wednesday, May 1, at the Criterion Restaurant. A number of distinguished men of science will be present, and the chair will be occupied by Lord Avebury. It is felt that the retirement of Sir Archibald Geikie from the position of director-general of the Geological Survey should not be permitted to pass without an expression of appreciation of his services to science and to the nation. All who are able will, we are sure, show by their presence at the dinner that they delight to do honour to one who has worked so worthily and with such success for the extension of scientific knowledge. Tickets may be obtained from Mr. F. W. Rudler, 28, Jermyn Street, S.W.

We regret to see the announcement of the death of Prof. H. A. Rowland, professor of physics at the Johns Hopkins University, Baltimore, U.S.A.

The Australian mail brings us news that Messrs. Baldwin Spencer and Gillen left Adelaide on March 15 for their twelve months' North Australian expedition. Owing to the presence of drought in the interior, the start, which was to have been made early in February, had to be delayed. The original intention of the explorers was to have worked out through the McDonnell Range and the Arunta tribes, and then north, until the mouth of either the Daly or Victoria river was reached; but it seems likely that this course might have to be given up in preference for an inverse one starting from Port Darwin,

which, with either the north and east or the west coast, was to have been the returning route. Our information from the explorers themselves is that they have simply "started away for the far north," but it affords us great pleasure to add that it embodies the news that, in addition to the 1000*l*. contributed to the expenses of the expedition by Mr. D. Syme, of the Melbourne *Argus*, there has been given a further sum of 500*l*. by Mr. Reuben Spencer, of Darley Hall, Manchester, father of the leader.

THE committee of the National Physical Laboratory will shortly appoint several members of the staff of the laboratory. Applications are invited for the post of superintendent of the engineering department; and other appointments to be made include two or three assistants in the physics department—one of them to take charge of chemical investigations—and a few unior assistants. Particulars as to salaries, &c., will be found in our advertisement columns.

MANY people wonder why the Thames is not used for passenger traffic to the same extent as the Seine. With a quick and punctual service, and neat vessels, the Thames might become the most popular means of travel in the metropolis. The Thames Steamboat Company possesses thirty-six vessels, having a total carrying capacity of more than sixteen thousand passengers. The vessels will be reviewed on May 1, and the service will commence on the following day. There will be a ten-minutes service between London Bridge and Battersea, a half-an-hour service between Chelsea and Kew, and a service of the same frequency eastwards from Westminster to Greenwich and Woolwich. It is sometimes objected that on account of the windings of the river the distance from one point to another is much greater than by road; but it must be remembered that omnibuses—with which the steamboats are comparable—follow routes which deviate from a direct line almost as much as the river. The better the service of steamboats on the Thames the more people will take advantage of this pleasant means of communication, and in the course of time London might be so well served in this respect as Paris is now.

THE Senate of Minnesota has passed a Bill prohibiting the marriage of insane, epileptic and idiotic persons, and requiring a medical certificate of all applicants for marriage licenses.

WE learn from *Engineering* that the valuable collection of early scientific works made by the late Mr. Latimer Clark, F.R.S., has been purchased by Mr. S. S. Wheeler and presented to the American Institute of Electrical Engineers. Mr. Andrew Carnegie has offered to provide the large sum necessary to house the entire collection in its new quarters.

THE Agricultural Research Association is a Scottish organisation, founded about twenty-five years ago and having for its objects the carrying out of two branches of work of the utmost importance to farmers, viz. scientific investigations bearing upon agriculture, and the dissemination of the information thus obtained among those to whom it is likely to be of practical use. The research station is at Glasterberry, Milltimber, Aberdeen. The Association has a strong list of names of patrons, office-bearers and members of the executive committee, and the director of research is Mr. Thomas Jamieson, of Aberdeen, under whose able administration some excellent work has been carried out and many most valuable results have been made public. From the report of the Association for the year 1900 it appears that experiments have at various times been conducted on the comparative values of finely ground and soluble phosphates, on the aperture in root hairs, on the relative values of different forms of nitrogenous, phosphatic and potash manures, on the cause of finger and toe disease in turnips, on the characters of roots of grasses and clovers, on the permanence of rye grass, and other subjects. Among the more recent inquiries has been a most carefully conducted set of experiments demonstrating that natural cross-fertilisation of oats leads to larger and more productive crops without extra outlay. It is proposed to extend the experiments to other crops in view of the decisive results obtained with oats. The Association is dependent on the subscriptions of landowners and farmers, and although the latter take the greatest personal interest in the work, the amount of the subscriptions has been insufficient to meet the necessary expenditure, and the director has in consequence had to meet the deficiency incurred during last year's work. In view of the practical value, to say nothing of the scientific importance, of the results hitherto achieved, it is to be hoped that the appeal of the committee for a further measure of support will meet with that response on the part of the landowners which the work of the Association most certainly merits.

THE Easter party is now at work at the Port Erin Biological Station. The curator, Mr. H. C. Chadwick, who has recently been for a couple of weeks at the Lancashire Sea-Fisheries Hatchery, making himself acquainted with the methods employed there, has now returned to Port Erin, and Prof. Herdman is there with a party of students. Dr. O. V. Darbishire, from Owens College, occupies a table and is at work on his forthcoming L.M.B.C. memoir on Gigartina; Miss Thornely, of Liverpool, is examining Polyzoa, and there are three senior students from the zoological department of Owens College at work. Other naturalists are expected during the latter part of this month. The boisterous weather of late has prevented much work at sea, but several shore collecting expeditions have taken place, and arrangements have been made for a steam-trawler for dredging. This is a late season amongst marine animals in the Irish Sea, probably on account of the recent cold weather. The fish spawning is not so far advanced as is usual at this time, and sedentary colonial animals, like compound ascidians, on the shore seem to be less abundant and smaller than usual. In the tanks of the Aquarium several common shore invertebrates are now spawning; Ephyræ made their appearance in swarms during the greater part of March; *Porania pulvillus*, obtained on dredging expeditions from deep water, has established itself and is living healthily; while several of the large wooden tanks contain crops of self-planted algæ and other small organisms, and support a varied fauna without change of water and with very little attention.

WE learn from *Science* that the following grants from the Gould Fund have recently been made:—to Mr. John A. Parkhurst, 30 dollars; to Dr. Herman S. Davis, 500 dollars; to Mr. Paul S. Yendell, 225 dollars; to Prof. Simon Newcomb, 25 dollars. A considerable additional amount of income has accrued, for the distribution of which applications are awaited. These applications may be made by letter to any of the directors, stating the amount desired, the nature of the proposed investigation, and the manner in which the money is to be expended. The directors, desiring to stimulate the participation of American astronomers in the attempt to bring up the arrears of cometary research, offer to them the sum of 500 dollars for computation of the "definitive" orbits of comets, this sum to be distributed at the average rate of 100 dollars for each computation—the amount to vary according to the relative difficulty of the computation, and to be determined by the directors of the Gould Fund. Computers should promptly notify the directors of their participation or desire to participate, and manuscripts should be submitted not later than July 1, 1902.

Apropos of the red rains of African dust which have recently excited considerable attention in the south of Italy, Dr. H. R. Mill, the editor of *Symons's Meteorological Magazine*, directs attention, in the issue for the current month, to a blood-rain plant which has invaded the large evaporation tank at Camden

Square. The plant has been examined microscopically by Mr. V. H. Blackman, of the Botanical Department of the British Museum, and is found to be a minute motile alga called *Sphaerella pluvialis*. It is usually found in small pools, and is closely allied to the microscopic plant which gives its colour to red snow. Its occurrence in rain is a rarity, and it has nothing in common with the red sand-rains of the Continent—except the colour—but if a whirlwind were to pass over the tank, showers coloured red might be produced along its subsequent track by the same process as the familiar showers of frogs and fish.

We have received from the director of the Meteorological Service of Canada an interesting account of the cloud observations made at the Toronto Observatory during 1896 and 1897. The instruments used consisted essentially of two ordinary surveyor's theodolites, the telescopes being replaced by a long axis made for each and mounted in the Y's of the standards. The length of the base line was 1552 metres; the observer at one station selects some well-defined point of a cloud and telephones its position to the observer at the other station, and on his identifying it the two observers sight it at the same instant of time, and this operation is repeated after an interval varying from 40 seconds to 8 or 10 minutes. Not much photography was done, owing to the difficulty of keeping the cameras in adjustment. The highest cirrus measured in the latter part of 1896 was at 10,000 metres, velocity 79 miles an hour, and the lowest 8100 metres, velocity 55 miles. In June 1897, altitudes exceeding 11,000 metres were obtained, with velocities of about 100 to 150 miles an hour. Mean height during the summer season was 10,900 metres, mean velocity 40 miles, and in the winter season 9,978 metres, velocity 26 miles. The heights and velocities of the various clouds are given in the same way, the mean heights of the lowest cloud, the cumulus, being in the summer season 1697 metres and in the winter season 1326 metres; the mean velocity was only about 10 miles an hour.

The second sheet of the North Atlantic and Mediterranean Pilot Charts, issued by the Meteorological Office last week, exhibits the salient features of the region in the month of May. In dealing with the winds it is pointed out that, as indicated by the isobars on one of the inset charts, the barometric gradient between the anticyclone of the horse latitudes and the depression near Iceland is now only about ¼ inch, so that the winds over the northern half of the Atlantic are of moderate force and strong gales are uncommon, the southern limit of 10 per cent. frequency of gales receding northward to between the 45th and and 50th parallels. Some characteristics of the tornadoes on the African coast are mentioned, and advice given as to how a vessel should be handled. It is instructive to observe that with the advance of the year fog is not only increasing on the banks but the area is creeping eastward, while another area is spreading westward from the Bay of Biscay. The great advantages of ocean current charts for each month of the year are becoming very evident. To quote the latest chart, "The results show the changes, both local and general, which are associated with the advance of the seasons. In the month of May it will be seen that to the westward of the British Isles, between the 50th and 60th parallels, the drift is largely to the west and south-west, there being no evidence of the north-eastward extension of the Gulf Stream beyond about 47° N., 27° W. Between the 30th and 50th parallels westward to the 30th meridian, nearly the whole of the surface water has a south-going movement. These features are probably closely related to the prevalence of polar winds off the coasts of North-Western Europe at this season." The distribution of atmospheric pressure, with the accompanying northerly winds, distinguishing the European "Cold Spell" of May, is illustrated by means of an inset chart and remarks, and there is information bearing on several other topics; but sufficient has been said to show that the chart may be of service to many others in addition to seamen.

The Sydney Botanic Gardens, which are admittedly among the finest in existence, comprise about forty acres, and their northern edge forms a semicircle round Farm Cove, one of the many charming indents of the harbour, and forming the anchorage of the vessels belonging to the Australasian squadron. Adjoining the western boundary of the gardens are the grounds surrounding the residence of the Australian Governor-General. Recently the gardens have been enriched by the addition of the first museum in Australia strictly botanical in character, all existing museums in which plant products are exhibited being either technological or partly botanical and partly technological. The building, which has been erected under the supervision of the State Government architect, now comprises a museum, herbarium, library, store room, photographic room, seed room and offices. The museum was formally opened by Mrs. John See, whose husband, the acting-Premier and Chief Secretary of New South Wales, said the collection was a national one, and that so long as he occupied the position he would do all he could to provide money for extending its usefulness.

Dr. B. Sharp described, at a recent meeting of the Academy of Natural Sciences of Philadelphia, some observations he has made on the contents of the stomachs of the common cod. Several hundred stomachs were opened with the hope of finding shells of gastropods and bivalves. Numerous valuable shells were taken from the cod years ago by Stimpson and Gould on the New England coast, north of Cape Cod, and it was supposed that similar finds would come to light from the cod caught off Nantucket. The stomachs examined were filled almost exclusively with crustaceans and for the most part with species of Panopeus. Hermit crabs, without shells, and a few Crepidulæ were also seen. Here and there young lobsters were found in the stomachs, occasionally two in one stomach. Dr. Sharp believes that the decrease in quantity of the lobsters, which has been so marked within the past few years, is partly due to their consumption by the cod; and as these have of late greatly increased in numbers, owing to the work of the United States Fish Commission, the lobsters have not been able to keep pace with the increase of their enemies.

Petermann's Mitteilungen contains a short descriptive paper on the region surrounding the junction of the Trombetas with the Amazon, by Dr. Friedrich Katzer, with a map based on surveys made under direction of the Belgian engineer, Haag, chiefly by Captains Le Blanc and Robert. The map indicates considerable modifications of those already extant.

Prof. E. Richter communicates to *Petermann's Mitteilungen* a letter addressed to him by Herr Schuh, of Gmunden, on some temperature observations made in the Gmunden See, which seem to settle the question of why water at the surface of a lake on which ice is forming has always been recorded as warmer than the freezing point. Using an ordinary thermometer, Herr Schuh observed temperatures of 0°·4, 1°·5, 2°·0 and 3°·4 C. within an area of 1 sq. m. on which ice was actually forming. A special form of thermometer was then devised, of which the lower part was drawn out into the form of a pear 7 mm. in diameter, the instrument being filled with spirit and carrying a minimum index, and the whole was so arranged as to swim on the water with the pear-shaped part immersed horizontally. Repeated observations showed that where ice was forming the spirit showed a temperature of 1° to 3° when the instrument was lifted out of the water, but the index invariably read 0° C. Hence it appears that the

ice-forming layer is one of extreme thinness just at the surface, and that in observing with the ordinary thermometer this layer gets mixed with the warmer water underneath.

A MATHEMATICAL investigation of the motions of seismographs, which from its nature bids fair to have important applications, is published by Dr. M. Contarini in the *Atti dei Lincei*, x. 5, 6. In it the author determines the differential equations regulating the motion of the forms of seismograph considered relative to three rectangular axes, and shows how these equations may be integrated. The assumption on which this work is based is that all the points of attachment, both of the pendular masses and of the registering levers, are treated as being rigidly connected with the earth.

IN the *Bulletin* of the Cracow Academy, November 1900, Herr Zorawski studies the motion of a continuous system of material points regarded as a group with the infinitesimal transformation determined by the well-known operator of the ordinary equations of hydrodynamics. It appears that if the characteristic equation possesses three distinct roots, the principal axes of the quadric connecting the rates of strain are transformed into principal axes, if two roots of the characteristic equation are equal only one principal axis is transformed into a principal axis, finally, in the case of a triple root, the line element possesses properties which the author designates as "perfectly symmetrical."

THE resistance of cereal smuts to formalin and hot water forms the subject of a short paper by Mr. William Stuart in the *Proceedings* for 1898 of the Indiana Academy of Science, which has recently reached us. The results obtained in the treatment of the spores are well within the bounds of successful practice, the spores being much more easily injured with either hot water or formalin than is the grain. It is apparent that the essential feature in the successful treatment of grain for smut is to bring each seed in contact with the solution used for a sufficent length of time to enable it to reach the spores. The advantage possessed by formalin over hot water in the treatment of seed grain lies in its greater ease of application, doing away with the necessity of heating water and maintaining a sufficiently uniform temperature during the treatment. Mr. Mason B. Thomas describes some field experiments with formalin in the same volume.

PART 67 of the *Communications* from the Leyden Physical Laboratory contains a paper by J. C. Schalkwijk on precise isothermals, in which the author describes methods of determining the corrections to be applied in taking account of the volume of the meniscus of mercury in working with standard gas-manometers.

A DISCUSSION on the properties of steel containing nickel is presented to the Report of the Congrés International des Méthodes d'Essai (Paris, 1900). In passing from ordinary steel to that containing a considerable proportion of nickel the principal changes are the lowering of the temperature of transformation of the carbon, the fusion of two of the transformations and the exaggeration of the phenomena accompanying the double point. In ferro-nickels containing traces of carbon, but more than 20 per cent. of nickel, the transformations are determined by the nickel, the carbon acting as a retardent. It appears that the magnetic properties are due to a certain molecular transformation which takes place with evolution of heat, and when this molecular grouping is prevented by the presence of some other body, the metal may be reduced to ordinary temperatures without exhibiting magnetic phenomena. The author compares ferro-nickels to solutions rather than combinations. Finally, it is suggested that by the addition of nickel many properties of steel may be studied at temperatures considerably below those at which they occur in pure steel. As an example the author mentions the gradual changes of volume which take place in the course of years, and which in the case of nickel steels may be observed at the temperature of the laboratory, whereas it would be impossible to study similar changes occurring at an elevated temperature in pure steel.

IN the April number of the *Zoologist* Mr. J. H. Gurney mentions that the nestling of the green woodpecker, when a few days old, develops a pea-like knob on each side of the hinder part of the mandible. It would be interesting to discover the use of this peculiar growth, which appears to have been hitherto unnoticed.

A LARGE portion of vol. xxii. part 3 of *Notes* from the Leyden Museum is taken up by instalments of Dr. O. Finsch's catalogue of the birds in the collection; these deal with certain eagles, the parrots of the South Sea islands, and various passerines. Another article, by Dr. Jentink, treats of certain alleged errors in the description of the large West African diuker antelope (*Cephalophus sylvicultor*). Considering that one of the articles is dated March 1901, it is somewhat difficult to understand why this part of the *Notes* is issued for July 1900.

PART 3 of vol. lxix. of the *Zeitschrift für wissenschaftliche Zoologie* contains six memoirs, five of which deal with the anatomy and morphology of invertebrates, while the sixth (by Herr E. Botezat) treats of the nerves of the hard palate of mammals, a subject which has hitherto received but little attention from anatomists. To specialists, Prof. F. Vejdovský's communication on the morphology of the antennæ and shell-glands of the crustacea should prove interesting. Another paper, by Herr N. Kassianow, deals with the nervous system of the lucernarian medusæ.

THE concluding portion of Mr. E. J. B. Sopp's address on the importance of the study of life-history among insects is published in the *Entomologist* for April. After mentioning that insects in captivity are often somewhat misleading in their habits, and that all observations should be verified on specimens in the wild condition, the author cites a few instances where our ignorance of insect physiology is most noticeable. It is quite unknown, for example, how the water-beetles of the genus Dytiscus produce their well-known stridulating sound. Neither do we know the use of the peculiar cord-like structure found in "bloodworms," or larvæ of the gnat-like fly *Chironomus plumosus*, nor how the respiratory air-sacs of the "phantom larvæ" of another gnat, *Corethra plumicornis*, become inflated with air, and that, too, in all probability of a highly oxygenated character. The author also calls attention to the importance of coalition between natural history societies for the purpose of recording the local abundance of insects in their respective districts. It is the common and not the rare species to which attention should be directed, as by this means we may in time be able to predict and thus prevent the appearance of "plagues" of noxious kinds.

A DESCRIPTIVE catalogue of the Coleoptera of South Africa, by Mr. L. Péringuey, assistant director of the South African Museum, constitutes vol. xii. of the *Transactions* of the South African Philosophical Society. The catalogue occupies 563 pages, and is illustrated by nine plates.

WE have received a copy of *Electrical Investments*, a new fortnightly journal devoted mainly to the financial side of electrical undertakings. Besides an extensive share list, the paper contains a leading article and comments on matters of interest to those concerned, financially or otherwise, with electrical matters.

IT will interest archæologists to know that the concluding volume (vol. iv.) of "Old Northern Runic Monuments of Scandinavia and England," by the late Prof. George Stephens, will be published shortly in English by Messrs. Williams and Norgate. The work was left incomplete by Prof. Stephens, but from his notes and papers his son has been enabled to prepare the volume for publication.

MUCH information not easily obtainable is brought together in a little publication just added to the Patent Office Library Series, of which it forms No. 4, under the title "Guide to the Search Department of the Patent Office Library, with a Dictionary of 'Trade or Fancy' Names." The book shows in what publications, and for what periods, grants of patents and registration of trade marks and designs are recorded, the information being arranged under the names of countries. The dictionary of words used to designate materials, processes and mechanical appliances will often prove of service, for the etymology of the words rarely gives a clue to the nature of the things designated.

THE *Proceedings* of the American Association for the Advancement of Science, containing addresses and abstracts of papers read at the forty-ninth meeting, held last June in New York, have just been received. By an arrangement with the Macmillan Company, members of the Association now receive the weekly journal, *Science*, free of charge; and as the journal publishes the official notices and proceedings of the Association, the members are kept in touch with these affairs as well as with the progress of science in return for their single subscription.

THE *Psychological Index* this year occupies 179 pages of the special number of the *Psychological Review*. The index is a bibliography of the literature of psychology and cognate subjects for the year 1900, and includes publications in all languages, together with translations and new editions in French, German and English. There is a comprehensive subject-index, containing 2627 entries, and also an authors' index. Prof. H. C. Warren, of Princeton University, who is the compiler of the index, deserves the thanks of psychologists for the careful way in which he has done his work.

"THE Handbook of Jamaica" for 1901, compiled by Messrs. T. L. Roxburgh and J. C. Ford, has been published by Mr. Edward Stanford. The work is now in its twenty-first year of publication, and contains an immense amount of historical, statistical and general information concerning the island

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by the Rev. J. M. Glubb; a Bennett's Wallaby (*Macropus bennetti*) from Tasmania, presented by Mrs. L. Brown; a Water Rail (*Rallus aquaticus*), British, presented by Mr. A. W. Arrowsmith; a Blue-breasted Waxbill (*Estrelda cyanogastra*) from West Africa, presented by Miss E. C. Stephens; a Raven (*Corvus corax*), European, presented by Mr. J. C. Cadogan; two Red-eared Bulbuls (*Pycnonotus jocosus*), a Red-vented Bulbul (*Pycnonotus haemorrhous*) from India, a Chinese Bulbul (*Pycnonotus sinensis*), a Chinese White-eye (*Zosterops simplex*), a Chinese Mynah (*Acridotheres cristatellus*) from China, a Wattled Honey-eater (*Anthochaera carunculata*) from Australia, a Black Tanager (*Tachyphonus melaleucus*), a Silky Cow-bird (*Molothrus bonariensis*), a Red-headed Marsh-bird (*Agelaeus ruficapillus*), two Sulphury Tyrants (*Pitangus sulphuratus*) from South America, a Brazilian Tanager (*Ramphocoelus brasilius*), a Red-headed Cardinal (*Paroaria larvata*), a Brazilian Hangnest (*Icterus jamaicai*), a Bay Cow-bird (*Molothrus badius*) from Brazil, a Black-tailed Hawfinch (*Coccothraustes melanurus*) from Japan, a Long-tailed Glossy Starling (*Lamprotornis aeneus*) from West Africa, a Nutcracker (*Nucifraga caryocatactes*), European, two Black Larks (*Melanocorypha yeltonensis*) from Siberia, presented by Mr. J. M. C. Johnston; a One-wattled Cassowary (*Casuarius uniappendiculatus*) from New Guinea, a Blackish Sternothere (*Sternothoerus nigricans*) from Madagascar, Six Ceylonese Terrapins (*Nicoria trijuga*), three Bungoma River Turtle (*Emyda granosa*) from India, a Black Tortoise (*Testudo nigra*) from the Galapagos Islands, deposited; a Garnett's Galago (*Galago garnetti*) from East Africa, three Brazilian Grosbeaks (*Guiraca cyanea*) from Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY.

May 1.	15h. 18m. to 16h. 19m. Moon occults *i* Virginis (mag. 5·5).
1–6.	Epoch of Aquarid meteoric shower (Radiant 338°—2°).
3.	4h. 6m. to 8h. 55m. A penumbral eclipse of the moon.
3.	6h. 31m. Middle of the eclipse.
3.	7h. 28m. Moon rises at Greenwich.
7.	12h. 39m. to 13h. 51m. Moon occults 21 Sagittarii (mag. 4·9).
8.	12h. 26m. to 13h. 23m. Moon occults *d* Sagittarii (mag. 4·9).
8.	13h. Saturn in conjunction with moon. Saturn 3° 48′ South.
9.	13h. 3m. to 14h. 59m. Transit of Jupiter's Sat. IV.
12.	11h. 48m. Minimum of Algol (β Persei).
13.	13h. 57m. to 14h. 48m. Moon occults λ Piscium (mag. 4·7).
14.	11h. 30m. to 14h. 34m. Transit of Jupiter's Sat. III.
15.	Venus. Illuminated portion of disc = 0·998.
15.	Mars. Illuminated portion of disc = 0·895.
17.	17h. 29m. Sun eclipsed, invisible at Greenwich.
21.	15h. 1m. Transit (ingress) of Jupiter's Sat. III.
25.	Saturn. Outer minor axis of outer ring = 17″·06.
31.	11h. 49m. to 12h. 36m. Moon occults B.A.C. 5109 (mag. 5·4).

NEW VARIABLE STAR 70 (1901) URSA MAJORIS.—In the *Astronomische Nachrichten* (Bd. 155, No. 3701) Dr. T. D. Anderson announces the discovery of a new variable star having the position

$$\left.\begin{array}{l}\text{R.A.} = 8\text{h. } 57\cdot9\text{m.}\\ \text{Decl.} = +51° \;\; 42'\end{array}\right\}(1855).$$

The magnitudes observed were :—

1901	February	13	...	10·4
		15	...	10·4
	March	24	...	9·8
		27	...	9·7
	April	3	...	9·6

NOVA PERSEI.—Prof. H. C. Vogel gives particulars of some of his later work on the spectrum of the new star in the *Astronomische Nachrichten* (Bd. 155, No. 3701). Measures of seven lines between H_α and H_β are given, being ascribed to sodium, helium and possibly magnesium. A discussion is included of the possible explanation of the great width of the lines by the work of Humphrey and Mohler, Wilsing and others.

Herr J. Plassmann, the well-known variable star observer, gives a series of estimates, by Argelander's method, of the brightness of the Nova from February 23 to March 27. In many cases estimates taken at different times during the same night show the variation of the star (*Astronomische Nachrichten*, No. 3705).

REDUCTION OF PHOTOGRAPHS OF STELLAR SPECTRA.—Nos. 3702–3 of the *Astronomische Nachrichten* are devoted to a treatise by Dr. Hartmann on the measurement and reduction of photographs of stellar spectra, using the dispersion formula put forward by him some time ago, with special reference to the determination of velocities in the line of sight.

DR. METCHNIKOFF ON MICROBES AND THE HUMAN BODY.

A SPECIAL meeting of the Manchester Literary and Philosophical Society was held on Monday, April 22, when Dr. Elie Metchnikoff, of the Pasteur Institute, Paris, delivered the Wilde Lecture. Before the lecture, the president of the Society (Prof. Lamb) presented the Wilde Medal for 1901 to Dr. Metchnikoff, and the Wilde Premium for 1901 to Mr. Thomas Thorp.

Dr. Metchnikoff's lecture, which was in French, was on "La Flore microbienne du Corps humain." Dr. Metchnikoff explained that men were free from microbes at birth, but immediately after birth the surface of the skin and the mucous membranes became peopled with them, and at the end of some days they were numerous and varied. Their germs were derived from the air, or from the water used in washing the child. In summer they developed faster than in winter, and sometimes within four hours after birth there would be found several different sorts of microbes in the intestines. But as a rule their appearance was first observed between the tenth and seventeenth hour after birth. The habitation preferred by the microbes found in the skin was unquestionably the capillary follicles, a kind of deep sheath for the formation of hair. The mucous membranes, the surface of which was always moist and covered with substances by which microbes were readily nourished, were generally supplied with them more abundantly than the skin. The conjunctiva of the eye, however, thanks to its being continually washed by tears, usually rid itself of most of the microbes that found their way into the eye either with the fine dust in the air or through contact with the fingers. There was no doubt that microbes penetrated into the very deepest parts of the respiratory passages, though it was difficult to give a precise account of those ordinarily inhabiting the windpipe, the bronchial tubes and the lungs, since the presence of those which are found there after death might be explained by the intrusion, after death, of microbes from adjacent organs of the body. However that might be, the growth of microbes in the lower respiratory passages ought never, in a healthy man, to be great.

It was the digestive organs that exhibited them in the greatest abundance. Dr. Miller, of Berlin, had described more than thirty species inhabiting the cavity of the human mouth, some of them also to be found on the human skin; others, which were found about the teeth, were peculiar to the mouth and were not met with anywhere else. Several of the species characteristic of the mouth made their way deep into the digestive organs and were recognisable in the stomach and the intestines. The stomach, with its acid contents, offered conditions affecting in a quite exceptional way the development of microscopic growths. Many kinds of bacteria could not endure an acid environment; still, the bacterial system of the human stomach was pretty rich, thirty different species having already been distinguished, most of which were not found elsewhere in the digestive system. In the stomach, and still more in the small intestine, bacilli were the predominating form of microbe, the number and relative proportions of microbes in the small intestine varying with the food eaten. Meat and vegetable diets respectively stimulated the development of special bacterial forms, though even when the diet was unaltered noteworthy fluctuations in the microbian population were observable. From the smaller intestine the microbes passed to the larger, where they were joined by a great number of new kinds. Of all the parts of the human body, the large intestine was undoubtedly the most abundantly teeming with these growths. It was inhabited by about forty-five species of microbe, chiefly bacteria, among which bacilli were much the most numerous. The large intestine began to be inhabited immediately after birth. Even on the first day of life, before any food whatever had been taken, a fairly great variety of microbes was to be found there. When the child was suckled the population of the large intestine very soon underwent a change. It became more uniform and was composed mainly, and sometimes almost exclusively, of a particular bacillus. In children fed with the bottle, on cow's milk, this bacillus was found too, but in smaller numbers, the large intestine in these children being much richer in microbes of various types. After weaning, the abundance of microbes became much greater still. The number of distinct species of microbes to be found in a man in health could not be exactly estimated, but quite roughly and provisionally might be put between sixty and seventy.

What could one say of the function of these varied growths? Among invertebrate animals there were some covered with much more copious growths than were found on the human skin. On the southern and western coasts of England there was found in great numbers a kind of crab whose whole shell was generally covered thickly with vegetable growths. Their use was obvious. They assimilated the crab to the marine vegetation, and made him invisible alike to his enemies and to his prey. No such demonstration could be given of the utility of the microbes on the human skin. On the other hand, the flora of the cavity of the mouth might render man a service. Everybody had noticed that wounds inside the mouth healed much sooner than those on the outer skin. Moistened by the saliva, the wounds remained in contact with the microbes and their soluble products, which stimulated in a marked degree the reaction of the human organism. The secretions of the microbes attracted a great number of white blood-corpuscles, which cleaned the wound, cleared it of microbes and mortified tissues, and so favoured the process of recovery. In the lower parts of the digestive system this function of microbes was less important, the mucous membrane there being much more seldom torn. But it was probable that the acids secreted by many bacteria in the small intestine rendered a real service by preventing the development of certain other microbes which might impede digestion. This preventive function was manifested also in the course of conflict between the human organism and microbes of a very dangerous kind, and there was reason to believe that in some cases the germs of Asiatic cholera were rendered innocuous by the action of the microbes which they encountered in the intestines. It had also been contended by some authorities that the microbes in the digestive system played an important part in the digesting of food, and that without them food could not be assimilated; but the data available would lead rather to the general conclusion that for the normal action of the human digestion the presence of the intestinal microbes was by no means indispensable.

They should now try to ascertain whether the microbes in the human system might injure its health. When the defensive forces of the body flagged, whatever might be the reason, the microbes on the skin began to multiply and to pour their noxious products into the tissues and the blood. It often happened that serious boils and anthrax developed themselves in persons suffering from diabetes or some other general disease, their cause being, not the introduction of a morbid germ from without, but the excessive multiplication of certain microbes which are found in the healthy human skin and which now took advantage of the enfeeblement of the defensive cells. But the greatest harm was done by the microbes of the stomach and intestines. It had been recognised that the gravity of the danger incurred in cases of perforation of the intestines was due to the inflammatory action of the microbes that escaped into the peritoneum. Nor was the injurious effect restricted to cases where the microbes penetrated directly into the other organs or into the blood, for the microbes produced soluble substances which could be absorbed through the wall of the intestines and so make their way into the circulation. Several of these were substances more or less poisonous in their action, and it was very probable that a great many of these toxic products of our intestinal flora had still to be ascertained. In spite of our imperfect knowledge, there was reason to state, with the greatest strength of conviction, that the poisons produced by the intestinal microbes played a considerable part in causing many and various maladies. Headaches, exhaustion, neurasthenia, dyspeptic asthma, certain forms of epilepsy, several skin diseases, including acne, had by certain authorities been attributed wholly or in part to the action of poisons originated in the digestive system. Even in cases of mental disease its importance could not be denied; it had a noteworthy connection with diseases involving atrophy of the higher organs, such as the brain, the heart, the kidneys and the liver.

Dr. Metchnikoff then discussed at some length the relations of the normal microbian population of the human body—that is, the microbes present in it in a state of health—and the pathological microbes, or microbes directly inducing specific disease. He pointed to the methods practised in medicine and surgery to limit or counteract the action of microbes ascertainedly or potentially generative of disease, and to what he believed to be limitations to the beneficial operation of antiseptics. There was a tendency to renounce more or less completely the use of antiseptics, and to have recourse more and more to simply mechanical measures for keeping microbes out of the body—the prolonged washing of the hands, for instance, or the moistening

of the conjunctiva of the eye and other mucous membranes with liquids not strong enough to injure the living cells of the skin. The best method of antiseptic treatment of the intestine, merely relative as its efficacy might be, was now recognised in the use of drugs which produced frequent and abundant evacuation.

How were we to square the conviction that so many of the microbes usually found in the body were injurious with the argument, drawn from the work of Darwin, that if our microbes are so dangerous they ought long ago to have been eliminated simply by the operation of natural selection? One observed constantly that not merely natural characteristics unfavourable to their possessor's life, but even organs which had merely ceased to be useful to him, disappeared more or less completely. To bring out more clearly this paradoxical aspect of the survival of our microbes, most of which were not merely useless but unquestionably injurious, he would draw attention to the fact that the very organs of the body which sustained this flora were themselves for the most part either useless or injurious to health and life. They would remember that the ducts of the capillary follicles in the skin were the seat of a microbian vegetation often composed largely of microbes capable of producing more or less serious disease. Well, those follicles were useless organs, and represented merely what was left of the hair that covered the skin of animals who were our ancestors. In the digestive apparatus of man, the part of the body richest in microbes, there were also to be found parts which, to say the least of them, were now useless. The vermiform appendix, for instance, was the remains of an organ which was more fully developed in our animal forefathers; in the anthropoid apes it was already found in the process of reduction. Even the stomach, that organ which might seem so indispensable for digestion and the normal existence of man, was in reality nothing but a large reservoir for food, a reservoir which could without serious inconvenience be dispensed with. There were at that moment four persons living without stomachs, and thus furnishing a strong argument against the utility of that organ.

Of all the parts of our digestive system it was certainly the small intestine alone that was indispensable to the continuance of life. And yet in man, who could support himself on food easily digestible, the small intestine was disproportionately fully developed. Instead of having it between 18 and 21 feet long, man might do with one-third of that length. Kukula reported a case in which he had removed almost two-thirds of the small intestine with the greatest advantage to the patient. In one case Körte had removed, together with part of the small intestine, the greater part of the large intestine, leaving only the terminal section. As a result of this operation the patient had been completely cured. He could cite other cases of successful surgical operations to prove the uselessness of the large intestine to human beings. In one case the whole of the large intestine had atrophied of itself, without operation, in consequence of a fistula, without interfering with the active life of the subject. The sum of all this was that we possessed a voluminous and highly developed organ, the large intestine, which fulfilled no useful function and bred a very copious and varied mass of microbes, capable of injuring us through their poisons.

In face of thisf act it remained to ask what the large intestine was, what its origin and the reason of its existence. The history of the capillary follicles was comparatively simple, for they were the surviving traces of hair which had protected from the cold the animals from which man was descended. The large intestine, on the contrary, was no mere relic, but an organ highly developed. It was, as a rule, found only in the mammiferous animals, and not in birds, reptiles, or others of the lower vertebrates. Dr. Metchnikoff went on to trace in some detail the development of the large intestine to the prevalence of certain special conditions in the life of herbivorous vertebrate animals capable of running at great speed, conditions no longer present in the life of their descendants, and no longer calling for the peculiar organisation developed to meet them. The slow tendency of evolution to bring about the atrophy of such organs or characteristics might, however, be assisted by medicine and surgery, medicine coping more effectually with the noxious microbes and their effects, while the progress of surgery had already brought it within its power to remove by operation organs or parts of organs propitious to the growth of the "flora."

Dr. Schunck proposed, and Prof. Hickson seconded, a vote of thanks to the lecturer, and the resolution was carried by acclamation.

MODERN METHODS OF GAS MANUFACTURE.

A PAPER on modern practice in the manufacture and distribution of illuminating gas was read by Mr. Harry E. Jones at the meeting of the Institution of Civil Engineers on April 16, and some of the points dealt with are here summarised.

The author remarked that improved returns from residuals at gasworks have been obtained by giving greater attention to the saving of fuel by the use of generator furnaces; by manufacturing the ammonia at the gas-works; by the preparation of cyanogen; and by the more extensive application of the antiseptics which are largely and cheaply produced from the tar.

The enrichment of gas, by reducing the return from residuals, has adversely affected the progress of gas-supply. The materials needed are all costly, and yield no return. Moreover, with incandescent burners, the cost of enrichment is wasted. Of the means of enrichment available, carburetted water-gas is preferred for cheapness and permanency. The advantages of this method are: facility for rapid and considerable addition to the output of gas, and for suspension of such additional supply without consequent expense; complete control of illuminating power over a wide range; avoidance of excessive accumulation of coke in winter; prevention of the deposit of naphthalene in the distributing mains and services, which formerly caused great loss and inconvenience; and reduction of space required by the plant, and for storage of materials. It was pointed out, however, that it is chiefly for mid-winter use, to relieve the strain on the coal-gas plant and the drain on the collieries, and to meet fogs and sudden climatic changes, that the system is profitable, as the price of oil advances with the price of coal, and to a figure that, having regard to value of residuals, cannot be paid without loss. During the winter of 1900–1901 the price of oil was practically prohibitive of its use, except for necessary enrichment or emergency use. Should it, however, be possible to supply unenriched water-gas, which, with the Welsbach burner, gives equal illuminating power, then the use of oil could be dispensed with and the combined coal- and water-gas processes could be carried on with a large saving and would enable the price of gas to be lowered by between 1*s*. 2*d*. and 1*s*. 8*d*. per 1000 cubic feet.

In purifying-plant the author recommended the abandonment of the old hydraulic seal, which is unstable, costly and very perishable. In his practice the entire cover is removable, being very light and held down by small bolts at the margin, and by bolts passing through both cover and floor and spaced at equal distances. The vessels are 8 feet deep and are arranged in groups of five worked in ordinary sequence, having both lime and oxide of iron in each. This system fulfils without nuisance all the requirements of the sulphur-purification demanded by the London Gas Referees without the cost, risk and space of the system of three separate groups previously necessary, in order, for carbonic acid, carbon bisulphide and sulphuretted hydrogen. For condensers the author prefers horizontal tubes, in which the tar and gas are cooled together, which have been found to remove naphthalene. Coke scrubbers are simplest and cheapest, and in practice more than secure the degree of purification from ammonia exacted by the London Gas Referees, and, by the ammonia retained, purifies the gas also from carbonic acid and sulphur. The residuals of gas are useful in purification, and a cycle of reactions was traced in the processes of manufacturing sulphate of ammonia by sulphuric acid made partly from the sulphur in the ammoniacal liquor and partly from that in the residual spent oxide of iron from purifiers.

The pressure for distribution of gas is usually 3 inches to 4 inches head of water, but Mr. C. C. Carpenter has for some time been delivering by means of Sturtevant fans, at pressures between 12 inches and 18 inches. In America distribution has been accomplished over long distances by employment of pressures of several pounds per square inch. Service pipes are now laid in steam-tubing 30 per cent. thicker than gas-tubing; they are coated with pitch before filling the ground in, and their life has thus been extended from 12 years or 14 years to more than 20 years. Meters of the "dry" form are now invariably employed, which, if examined periodically, at intervals of 6 or 8 years, can be maintained fairly accurate; by improvements in manufacture their life has been increased from 12 years to nearly 20 years.

THE FORMATION OF WAVE SURFACES IN SAND.[1]

ATTENTION was first called to tidal sand ripples by Prof. Osborne Reynolds,[2] who found them submerged in channels between sand banks in estuaries. My observations were on tidal sand ripples which I found above low water (Fig. 1). They are generally unsymmetrical in form, with the steep face on the sheltered side, as are "current marks" and æolian sand ripples. They apparently do not require for their formation any co-operation between flood and ebb currents, although where such co-operation occurs, the wave fronts probably become less sinuous. They are to be seen, not only in tidal estuaries, but also in some localities on the seashore[1] where the sands are exposed to waves as well as to currents, but they face with the current, not with the waves, and are thus readily distinguished from the wave-formed ripple mark. The smallest tidal sand ripples which I have found exposed at low tide were 3 feet from crest to crest, and all sizes from this to 20 feet wave-length are common. On a sand bank in the Dovey estuary (North Wales), opposite to the town of Aberdovey, I marked out a plot with stakes driven deeply into the sand, and recorded by daily measurements the increase, diminution and march of the sand waves. At neap tides the sands were nearly smooth, and as the tides increased the tidal sand ripples appeared, short and relatively steep. The amplitude increased steadily, the average wave-length also increased, apparently by elimination of some of the ridges. When the highest spring tide was passed the amplitude rapidly diminished, the wave-length remaining nearly, but not quite, constant, and the mean sand level remaining practically unchanged. Details of the measurements will be given in the *Geographical Journal*. The circumstances favourable to the formation and preservation of tidal sand ripples above low-water mark are, gentle current at first of the flood and last of the ebb, and strong current when the water is deep over the sands. I have often watched the course of events when the last of the ebb has been running over the ridges. The process is then one of decay, not of growth, the sand being swept from the crests into the troughs. What goes on during the *growth* of the ridges? Let the depth of water be sufficient; then, if the velocity of the current be small, the sand grains roll and slide along the bottom, but, as the speed increases, the water, almost suddenly, becomes highly charged with sand in "eddying suspension." A uniform current flowing swiftly over extensive sands picks up as much sand as it drops, thus causing a drift of sand which on the whole is uniform, neither raising nor lowering the bed.[2] My observations indicate, however, that *in detail* the drift is not uniform, but attended by alternate silt and scour along lines at right angles to the current and equidistant from one another, the surface of the sand bank being thus carved into transverse ridge and furrow without change of mean level. The slightest convexity of surface causes a convergence of currents, a concavity a divergence, and, under the conditions specified, deposition occurs upon the convexities, whilst the concavities are scoured. The vertical inequalities are thus increased,[3] and it is easy to see that the ridges will extend themselves laterally.[4] Thus the ridge and furrow inevitably form and grow. What, then, are the limits of this growth? Obviously the depth of water is one limit. When the cross section of the stream above the sand ridge is reduced by a certain amount, the greater force of water there

FIG. 1.—Tidal sand ridges in the Dovey estuary. Photograph taken June 15, 1900. Wave-lengths about 15 feet.

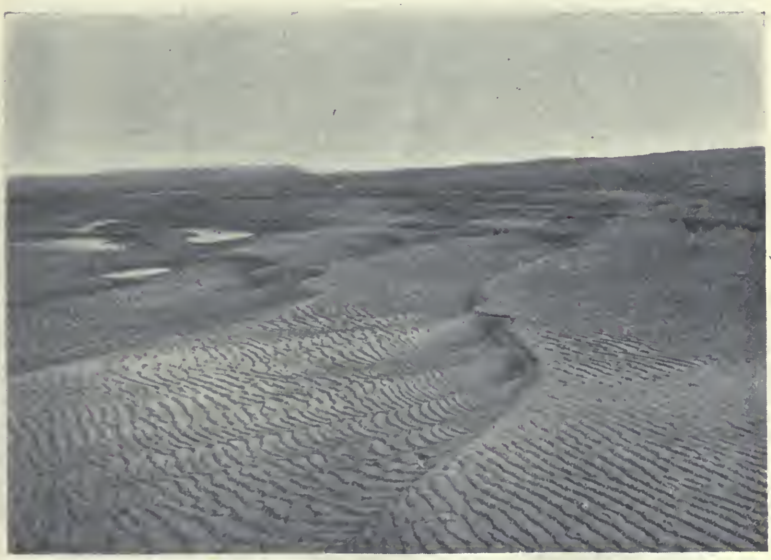

FIG. 2.—Current mark upon tidal sand ridges. Photograph taken June 15, 1900, in the Dovey estuary.

[1] Abridged from a paper by Mr. Vaughan Cornish in the *Scottish Geographical Magazine*, January 1901.

[2] Reports of committee appointed to investigate the action of waves and currents on the beds and foreshores of estuaries by means of working models.—*British Association Reports* of meetings of 1889, 1890 and 1891.

[1] And on the Goodwin Sands, where I found them, May 12, 1900. [Since the paper was written I have seen the same structures in a non-tidal part of the Fraser River, British Columbia.]

[2] *British Association Report*, Manchester meeting (1887). Osborne Reynolds on "Certain Laws relating to the Régime of Rivers and Estuaries and on the Possibility of Experiments on a small scale."

[3] Compare G. H. Darwin's observation of the sand creeping up both sides of a ridge when a current was caused to flow over it.—*Proc. Roy. Soc.*, vol. xxxvi. 1883; "On Ripple Mark."

[4] Compare James Thompson on the "Winding of Rivers in Alluvial Plains."—*Proc. Roy. Soc.*, 1876 and 1877.

removes the sand as quickly as it is brought, and further growth is thus stopped. If the depth be further reduced, *e.g.* during an ebbing tide, the ridges decay. In deep water the height of the ridges is limited to that at which the velocity of the stream can maintain an active eddy on the lee of the ridge, and if the velocity be reduced the troughs silt up owing to the sand falling into dead water. It is probable, also, that the amplitude is sometimes restricted by the velocity of the current surpassing the limit suitable to the fineness or lightness of the material of which the ridges are composed. For it is evident that there is a difference between the pressure upon the weather side and upon the lee side of a ridge. I notice when wading on sand banks ridged with tidal sand ripples that the pressure of one's tread often causes a bodily sliding of the sand from trough to crest. The growth and even the maintenance of the ripples demands a *differential* movement of the material. There must be a part to stand fast as well as a part to be redistributed. Thus a moderate range in the sizes of the particles of the loose granular material is favourable to the formation and retention of a wavy surface through a considerable range of velocity of the inducing fluid. It is evident that two sets of crossing ridges cannot be simultaneously produced by true current action, and, in fact, crossing tidal sand ripples are seldom seen. Sometimes, when the direction of current has suddenly changed at a particular time of tide, two sets of ridges are successively formed. The "tidal sand ripples" seem, in fact, to be true current-formed sand waves. They are themselves rippled over with "current mark," which is more properly a ripple, in that (like capillary ripples) it only goes skin-deep (Fig. 2). It seems to be due rather to the pulsations of a current than to the current as such. I have often seen little sand ripples in fairly deep rapid streams, which I suppose would properly be called current mark, facing obliquely or transversely to the direction in which the sand was travelling. This was near the shore where the most marked pulsation was shorewards.

I have described elsewhere[1] some little dunes formed by the wind out of the very fine and light sand of the dry Nile bed, when the river was at its lowest. These dunes, which in size and shape somewhat resembled tidal sand ridges, were covered with a beautiful tracery of little ripples. In the formation of the æolian sand ripples the heterogeneity of the sand plays a much more important, the pulsation of the fluid a much less important, part than in the case of the current mark of streams. I have one more observation on this point to add to those already published. I noticed, during strong winds lasting several days, at Montrose, N.B., March 1900, that the rippling of the remarkably uniform dry drifting sand was very slow in beginning. As soon, however, as there was a fair supply of the coarser kind of sand grains aggregated together, the rippling action went on vigorously and rapidly. A moderate range of sizes of material, *e.g.* fine sand and coarse sand, is best for æolian rippling. In the vicinity of big stones the scour of the wind is too great. During the occasions on which I visited this little dune tract the strong breeze drifted the fine light sand thickly near the surface, and in the afternoons there was a haze of flying sand extending 20–30 feet above the foreland. The conditions were, in fact, very similar to those with which I have since become familiar in the case of formation of tidal sand ripples. It seems highly probable that the fine, light sand in this wind was in a condition similar to the "eddying suspension" of water drift, proceeding in the manner described by Osborne Reynolds, plus the rapid increase of slight inequalities forming waves, as above described. The same brisk breezes which were forming dunes as regular trains of sand waves, as high as the quantity of dry Nile sand permitted, were not able to deal in the same free fashion with the coarse quartz sand of the larger desert dunes west nd east of the Delta.

FIG. 3.—Rippled clouds. Photograph taken August 5, 1900, near Bournemouth, 5.15 p.m., looking S.

FIG. 4.—The true aërial ripple mark. This is the negative of Fig. 3, and shows the ridges of still air between the whirling air of the clouds.

[1] "On Desert Sand Dunes Bordering the Nile Delta."—*Geogr. Journ.* January 1900.

Note on Photographing Aërial Ripple Mark.

Fig. 3 is reproduced from a photograph which I took of some remarkable ripple clouds near Bournemouth, on August 5, 1900, at about 5.15 p.m. The camera was pointed south; the sun, of course, is on the right, and the shadow of each cloud can be seen on the right-hand edge of the next one. These clouds were drifting rapidly to the east (left), the breeze at the ground level blowing towards the same direction. Ruskin wrote[1] long since of vapour "falling into ripples like sand." The general likeness is indeed striking, but the differences of detail are also noticeable, which is not to be wondered at, seeing that the cloud ripples are not the counterpart of the rippled sand, but of the whirling water between the sand ridges. How then shall we see the form of the aërial ripple mark where there is only blue sky? Simply by reproducing our photograph as a negative (Fig. 4). With this compare Fig. 5, an ordinary (positive) view of the wave-formed ripple mark of the strand, taken at Montrose, N.B., March 1900. Note the similarity of the sharp-topped ridges of still air, between the revolving cores where the clouds are, to the knife-edged ridges of the sand. But most remarkable of all is the precise correspondence of the confluence of ridges, wherever the wave-length of the ripple mark is about to change *per saltum* (for the wave-length of ripple mark increases in "multiple proportion," three ridges merging into two). And here our sky photographs are superior to, and throw light upon, our sand ripple mark photograph, for the latter had to be taken when the rippling action had ceased and the troughs were no longer filled with whirling water. Fig. 3, however, indicates what is going on where the ripple ridges are being merged, for the lights and shadows of the cloud indicate the activities of the working parts of the system. The rippled cloud here photographed, and consequently the true air ripples also, are symmetrical. This is not always the case; the clouds are often opaque (thick) at one edge and transparent (thin) at the other. In this case the form of the aërial ripple mark must be more like that of current mark, of æolian sand ripples and of tidal sand ripples. The likeness between cloud negative and sand ripple positive would be more striking but for the circumstance that we look up at the clouds and down at the sand. This makes the perspective different in the two. The real resemblance is best seen when separate prints are handled, one or other of which being inverted the perspective becomes similar in both.

Fig. 5.—Ripple mark of the strand. Photograph taken at Montrose, N.B., March 10, 1900.

[1] *Modern Painters*, vol. v. part 7, chap. i.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—A meeting of members of the Senate and others interested in the proposal to make some acknowledgment to Prof. Liveing for his valuable services to science and to the University will be held in the combination room of St. John's College on Saturday next, April 27, at 2.30 p.m.

Mr. Randolph Morgan, of Philadelphia, has given the sum of 200,000 dollars to the University of Pennsylvania for a new physical laboratory.

From the Catalogue of the University of Cincinnati, for 1900–1901, we see that the total endowment of the University amounts to 3,357,308 dollars, or nearly 700,000*l*. The latest large donation was in the year 1899, when Mr. David Sinton gave the University 100,000 dollars upon the condition that the income derived therefrom should be used in maintaining the Academic Department. The University has an observatory well equipped for carrying on astronomical work The observatory is at the present time co-operating with the International Geodetic Association in the determination of the variation of latitude.

Lord Curzon, Viceroy of India, visited on Tuesday the Mahomedan Anglo-Oriental College, which was founded at Aligarh by Sir Syed Ahmad in 1875 with the view of affording Mahomedan youths an opportunity of gaining a first-class education under English professors. A marked success has since been obtained, the Nizam and all the Mahomedan notables affording liberal support. Alluding to the desire of Mr. Beck, the late principal, who devoted his life to the College, to expand the institution into a residential University, the *Times* reports Lord Curzon to have said that the project had reached the ears of the late Queen, who inquired most sympathetically about it. Lord Curzon warned his hearers that they would never get from a University consisting of little but examining boards that lofty ideal of education, the sustained purpose and the spirit of personal devotion associated with the historic Universities of England, and also produced in some measure by the ancient Universities of Islam.

The reality of the competition between School Board classes and Technical Institutions in some places is clearly exemplified by the following extract, from the latest Report of the Governing Body of the Goldsmiths' Institute, New Cross—in every respect an excellent institution, where thorough instruction is given in science and technology. "The Governors in their last Report drew attention to the decline in the number of students attending certain classes. This decline began in 1898 (down to that year the class entries had been uniformly progressive), and was mainly due to the extension of the Free Evening Continuation Schools of the London School Board, and particularly to certain special centres which have been opened close to the Institute. It will be sufficient on the present occasion to state that the same causes still operate to check the natural growth of the classes affected." Reference has been made (p. 553) to the recent decision in the Court of Appeal that School Boards cannot legally support classes of this character or science schools out of the rates, but it has not yet been decided whether this ruling will be accepted. The foregoing extract emphasises the necessity for finally deciding upon the scope or area of influence of the various educational authorities, and so giving our educational system an organic structure in which each part has clearly defined work to do.

A meeting of the Agricultural Education Committee was held on Tuesday, Sir William Hart Dyke presiding. The executive committee reported that the two subjects most urgently requiring

attention at the present moment were:—(1) The union or co-ordination of the work of the Board of Education and the Board of Agriculture in dealing with agricultural and rural instruction; and (2) the training of teachers in nature knowledge and other rural subjects. Speaking upon the first of these subjects, Mr. Hobhouse, M.P., said the Board of Agriculture only inspected certain of the higher agricultural schools, and did not systematically advise or report on the work of the local authorities. It had no voice in drawing up schemes for agricultural instruction for which grants were given under the Directory or Code. It thus failed to take the position assumed by the agricultural departments of nearly every other country, including Ireland and our own colonies, where the progress of agriculture was systematically promoted by encouraging the best methods of instruction. The yearly sum devoted to agricultural instruction and research in the United States was (federal grants only) 700,000*l.*; in Canada, 156,000*l.*; in France, 152,460*l.*; and in Würtemberg, 65,000*l.*; while in England the sum was only about 15,000*l.* It would seem that the example of Scotland should be followed in England, and that the educational powers of the Board of Agriculture should be transferred to the Board of Education, especially as under the Board of Education Act, 1899, there already existed power to make a similar transfer by Order in Council. The Board of Agriculture would then, much to its own relief, cease to be an educational authority, though it might, perhaps, retain some supervision over certain experimental work carried on by agricultural societies.

SCIENTIFIC SERIALS.

American Journal of Science, April.—The magnetic theory of the solar corona, by F. H. Bigelow. A discussion of an experiment of Ebert on the behaviour of an electrified sphere in a magnetic field, when placed in a rarefied gas. The phenomena observed in the corona of the sun agree in a remarkable way with the effects produced in the above experiment.—Tertiary springs of Western Kansas and Oklahoma, by C. N. Gould.—Some fundamental propositions in the theory of elasticity. A study of primary or self-balancing stresses, by F. H. Cilley. A discussion of the effects of initial or "primary" strain of a body upon its elasticity. Since these strains and stresses are a component of the actual strains and stresses existing in substances, it is concluded that the latter cannot be defined through the equations of elasticity alone.—The boiling point of liquid hydrogen determined by the hydrogen and helium gas thermometers, by T. Dewar. From the *Proceedings* of the Royal Society.—On the nature of vowels, by E. W. Scripture. Reproductions of a magnified set of curves from a gramophone. The results tend to show that the movement of the air in the mouth cavity is a free vibration and not a forced one. The cord movements in the vowels are of the nature of explosive openings and not of the usual vibratory form found in most musical instruments.—Note on the behaviour of the phosphorus emanation in spherical condensers, by C. Barus.—The remarkable concretions of Ottawa County, Kansas, by W. T. Bell.

Annalen der Physik, April 1.—The application of the method of residual rays to the proof of the law of radiation, by H. Rubens and F. Kurlbaum. A discussion of the various expressions which have been proposed to show the relations between the intensity of radiation, the wave length and the temperature. A detailed account of the experimental methods is given, measurements being carried out at temperatures between $-180°$ C. and $1450°$ C., a graphical comparison being given between the experimental results and those calculated from the formulæ proposed by Wien, Thiesen, Rayleigh and Planck. The simple formula of Planck would appear to be the best hitherto proposed.—The elementary laws of electrodynamics, by E. Wiechert.—On the absorption of heat by carbonic acid, by S. Arrhenius. An account of the results of measurements of the absorptive capacity for heat of carbonic acid. The results are applied to the discussion of the effects of carbonic acid in the atmosphere upon the temperature of the air.—On the surface tension of water surfaces covered with an oil layer, and on the range of molecular action, by R. H. Weber. The value deduced from the experiments for the radius of molecular action is 115 $\mu\mu$., considerably greater than that deduced from the experiments of Reinold and Rucker, 10 to 17 $\mu\mu$.—On the phenomena in induction coils, by K. R. Johnson.—Mechanical vibrations of an isolated stretched wire with visible electrical discharges, by O. Viol. If an isolated stretched wire is charged from one end with electricity at high potential, transverse vibrations are set up in the wire, and if the electricity is negative and the charge sufficiently high for a visible discharge to take place along the wire, only the nodes appear to shine.—On the mode of action of coherers, by K. E. Guthe.—Contribution to the knowledge of the thermomagnetic longitudinal effect, by L. Lownds.—On the band spectra of alumina and nitrogen, by G. Berndt.—On the change of the absorption of light in solid bodies with the temperature, by J. Kœnigsberger.—On the influence of a resistance free from self-induction on the oscillatory discharge of a condenser, by T. Mizuno.—The air barometer, by H. A. Naber.—On the spectrum equation of polished platinum, by D. A. Goldhammer.—On the pressure of light rays, by D. A. Goldhammer.—On the magnetism of iron, by C. Fromme.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, March 21.—Prof. Thorpe, president, in the chair.—The following papers were read:—Researches on morphine, part ii., by S. B. Schryver and F. H. Lees. The authors have previously shown that bromomorphide is decomposed by water with formation of isomorphine, a base isomeric with morphine; it is now shown that another isomeride, β-isomorphine, is also produced in small quantity. Phosphorus trichloride converts codeine into chlorocodeide, which corresponds with bromomorphide and is convertible into isocodeine, a base isomeric with codeine.—The constitution of pilocarpine, part ii., by H. A. D. Jowett. Bromine acts upon isopilocarpine with formation of dibromoisopilocarpine perbromide and small quantities of monobromoisopilocarpine and isopilocarpinic acid; the latter is an oil of the composition $C_{11}H_{16}O_4N_2$. On oxidising dibromoisopilocarpine with permanganate, pilopinic acid, $C_8H_{11}O_4N$, and pilopic acid, $C_7H_{10}O_4$, are obtained. At 100°, in presence of water, bromine acts on isopilocarpine with production of dibromoisopilocarpinic, monobromoisopilocarpinic, bromopilopinic and bromopilopic acids.—The chemical action of *Bacillus coli communis* and similar organisms on carbohydrates and allied compounds, by A. Harden. The author has examined the products of the action of *B. coli communis* and *B. typhosus* on carbohydrates, and notes that the production of alcohol by the former organism appears to depend on the presence of the group $CH_2(OH)\cdot CH.OH$ in the compound to be fermented.—Action of dry silver oxide and ethyl iodide on benzoylacetic ester, deoxybenzoin and benzyl cyanide, by G. D. Lander.—Alkylation of acylarylamines, by G. D. Lander. Dry silver oxide and ethyl iodide convert the acylarylamines into the imino-ether, whilst if methyl iodide is substituted for ethyl iodide, a mixture of the imino-ether and the acylalkylamine usually results.—The preparation of aliphatic imino-ethers from amides, by G. D. Lander.—Note on the latent heats of evaporation of liquids, by H. Crompton.—On the atomic weight of lanthanum and on the error of the "sulphate method" for the determination of the "equivalent" of the rare earths, by B. Brauner and F. Pavlíček. It is shown that in the conversion of lanthanum oxide into sulphate for atomic weight determinations, small quantities of acid sulphate are produced and cause error in the determination of the equivalent; it is further shown that lanthanum, as hitherto known, is a mixture of two earth metals in which the true lanthanum of atomic weight 139·0 predominates.—On the atomic weight of praseodymium, by B. Brauner. The author has determined the atomic weight of praseodymium by four methods and made ebullioscopic determinations with the chloride in alcohol solutions; the final atomic weight of praseodymium is given as 140·94.—On praseodymium tetroxide and peroxide, by B. Brauner. Praseodymium tetroxide, Pr_2O_4, is obtained as a black powder, by fusing the nitrate with nitre and on treating praseodymium nitrate with hydrogen peroxide the hydrate of praseodymium peroxide, Pr_2O_5, is produced.—Note on neodymium, by B. Brauner. The number 143·5 was found by the sulphate method for the atomic weight of neodymium; this metal gives a tetroxide, Nd_2O_4, and a peroxide, Nd_2O_5.—Contribution to the chemistry of thorium, by B. Brauner. The author concludes that thorium does not consist of a single element because on fractional hydrolysis of ammonium thorium oxalate, fractions are obtained in which the

atomic weight of the metal varies from 220 to 232.—Pheno-α-ketoheptamethylene and its derivatives, by F. S. Kipping and A. E. Hunter. Pheno-α-ketoheptamethylene is obtained by the action of aluminium chloride on phenylvaleric chloride; its oxime is reducible to pheno-α-aminoheptamethylene,

$$C_6H_4\left\langle\begin{array}{l}CH_2.CH_2.CH_2\\ \qquad\qquad\quad |\\ CH(NH_2).CH_2\end{array}\right.$$

—Note on diphenyldinitroethylene, by J. J. Sudborough.—Para- and ortho-cyanohydroxy-derivatives of pyridine, by J. Moir.

Geological Society, April 3.—Mr. Horace W. Monckton, vice-president, in the chair.—The igneous rocks and associated sedimentary beds of the Tortworth inlier, by Prof. C. Lloyd Morgan, F.R.S. and Mr. S. H. Reynolds. It has long been known that igneous rocks occur in the district under consideration, but opinions are divided as to their intrusive or contemporaneous character. Evidence is here brought forward to show that the igneous rocks form two bands, the lower interbedded with Upper Llandovery strata, and the upper overlain by Wenlock, and that both bands are probably contemporaneous lavas. The microscopic examination of the lower igneous rock shows that it is a basaltic andesite containing plagioclase (acid andesine or oligoclase), pseudomorphs after enstatite, with chloritic and iron-oxide patches. The higher bed sometimes contains fresh augite, and both bands frequently contain rounded grains of quartz. In other examples the felspars appear in three forms, with augite and enstatite, and the rock ranges from an andesite to a porphyritic basalt. The quartz-grains present appear to be xenoliths. The silica-percentage of the rocks on a moisture-free basis varies from 61 to 67, while the specific gravities are from 2·74 to 2·99.

Linnean Society, April 4.—Mr. C. B. Clarke, F.R.S., vice-president, in the chair.—The secretary exhibited some British species of plants forwarded by M. Buysman, of Middelburg, to show the character of a proposed issue to include the whole of the British flora, on which some remarks were made by the chairman and Mr. James Groves.—Mr. W. B. Hemsley, F.R.S., exhibited specimens of Sapium and Hevea (Euphorbiaceæ) and Castilloa (Artocarpaceæ), with a view to clear up certain questions concerning the rubber-trees, by examining a large series of plants and seeds forwarded by Mr. Jenman, Government botanist in British Guiana. The genus Hevea included ten or a dozen described species inhabiting eastern tropical South America, but none in the West Indies. *Hevea brasiliensis*, the source of the true Pará rubber, was not very different from *Hevea guianensis*, which is restricted to French Guiana, the differences between them being shown in the figures given of the floral structure and seeds in Hooker's *Icones Plantarum*, plates 2570-2577. It was formerly supposed that two species of Hevea might be distinguished in British Guiana, one (*Hevea pauciflora*) having thin leaves and a hairy ovary, the other thick coriaceous leaves and a glabrous ovary; but after examining a large number of specimens, Mr. Hemsley had come to the conclusion that the differences were not constant, and that all the specimens exhibited might belong to one species, and merely represented individual variation. The exhibition demonstrated the difficulty of determining species of Hevea from imperfect specimens, and especially from seeds alone.—A paper was read by Messrs. W. B. Hemsley and H. H. Pearson on a small collection of dried plants made by Sir Martin Conway in the Bolivian Andes in 1898–99. This collection contained but forty-six species, but these were of special interest from the great height at which they were found, *i.e.* between 18,000 feet and 18,700 feet above sea-level. The highest Andine plants on record were stated to be *Malvastrum flabellatum*, Wedd., and a grass, *Deyeuxia glacialis*, Wedd.—A paper was read by Mr. G. S. West on some British freshwater Rhizopods and Heliozoa. When collecting freshwater algæ in different parts of the country the author had found Rhizopods and Heliozoa in abundance, and had preserved them for future examination. The observations now made related to their habits and structure, and comprised descriptions of peculiar forms of some of the commoner types, as well as remarks on several little-known species. Half a dozen species were described as new, and one (*Leptochlamys ampullacea*) was referred to a new genus. Two points of special interest were (1) the presence of a perforation at the apex of the shell in some forms of *Difflugia acuminata*, the shell thus possessing two openings: and (2) the possession of certain characters by members of the genus Vampyrella which sharply demarcate them from other Rhizopods. In the latter case, Mr. West had been able to observe several of these minute creatures feeding on the cell-contents of a species of Mougeotia.

Mathematical Society, Thursday, April 11.—Dr. Hobson, F.R.S., president, in the chair.—Mr. A. B. Basset, F.R.S., made a brief communication on the projective properties of cubic and quartic curves. Prof. Love, F.R.S., also made a few remarks on the communication.—A paper by Dr. F. Morley, entitled "Summation of the Series

$$\sum_{n=0}^{\infty}\Gamma^3(a+n)/\Gamma^3(1+n),"$$

was communicated by its title.—Lieut.-Colonel Cunningham, R.E., announced the factorisation of the algebraic prime factors of $5^{75}-1$ and of $5^{105}-1$.
The first =

151.3301. 183794551. 99244414459501,

and the second =

21226783250214361. 207468970805907721.

He has not determined the composition of the three large factors.

Zoological Society, April 16.—Mr. Howard Saunders, vice-president, in the chair.—A communication was read from Mr. W. L. Distant entitled, "A Revision of the Insects of the Order Rhynchota belonging to the Family Coreidæ in the Hope collection at Oxford." It was stated to be supplementary to the paper on the same subject already published in the *Proceedings* (*cf.* P.Z.S. 1900, p. 807)—Mr. F. E. Beddard, F.R.S., read a series of notes on earthworms, which comprised (1) an account of some earthworms from eastern tropical Africa in the collection of the British Museum; (2) a note on the spermatophores of *Polytoreutus*; (3) a note on the spermatophores of *Stuhlmannia*; (4) remarks on the ovaries, oviducts and spermducts of *Stuhlmannia*; and (5) a contribution to our knowledge of the genus *Gordiodrilus*.—Mr. F. E. Beddard also read a paper on the anatomy and systematic position of the open-billed stork (*Anastomus oscitans*), based on an examination of a specimen of this bird that had died in the Society's gardens. The author was of opinion that the structural differences between *Anastomus* and the typical storks were so slight that they did not warrant the placing of this bird in a separate family or subfamily.—A paper was read from Dr. H. Lyster Jameson giving an account of the mother-of-pearl oysters (*Margaritiferae*). It was based upon a study of the series of these oysters in the British Museum and upon an examination of a large series of marketable mother-of-pearl oysters of various species in the London shell-warehouses, and dealt with the specific identity, geographical distribution, local variation, original name and synonymy of the different members of *Margaritifera*. The subgenus was divided into two sections, characterised respectively by the absence or presence of rudimentary hinge-teeth. Several new species and local forms were described in this paper.—A communication from Miss Emily M. Sharpe contained a list of the Lepidoptera collected by Mr. Ewart S. Grogan during his expedition from the Cape to Cairo. The names of sixty-six species represented in the collection were enumerated in the paper. Two of these were described as new under the names *Amauris grogani* and *Gnophodes grogani*.

Royal Astronomical Society, April 12.—Prof. Turner read a paper by Mr. H. C. Plummer on a method for mechanically compensating the rotation of the field of a siderostat. Prof. Turner had in a previous paper given the principle of several methods by which this might be effected, but Mr. Plummer's appeared a still simpler arrangement. Prof. Turner gave an account of his own paper—Tables and Formulæ for connecting the Co-ordinates of Stars on different Photographic Plates—particularly in connection with the Astrographic Chart of the Heavens.—Mr. Bryant read a further investigation on the "two method" personal equation, in which he brought forward many interesting points in connection with the changes in the personal equation of three different observers at the Royal Observatory, Greenwich.—Mr. McClean read a paper on the spectrum of Nova Persei, and showed photographs, in which its spectrum was compared with those of η Argûs and Nova Normæ, Father

Sidgreaves had sent a communication in which the Nova was considered as a variable star with a variable spectrum.—Mr. Whittaker read some observations by Mr. Sharp of the changes of brightness in the Nova, and Dr. Rambaut read the observations made at the Radcliffe Observatory, Oxford. It appeared from these that while the light of the new star was steadily diminishing there had been fluctuations of brightness to the extent of about a magnitude and a half. Minima had been observed on March 22, 25, 28, 31, also on April 3 and 6. The latter minimum was prolonged to April 7, after which the light increased, and again diminished.—Papers by Mr. Innes on anomalous occultations of stars by the moon, and by Mr. Denning on meteoric showers from the region between α and β Persei were also read.

Paris.

Academy of Sciences, April 15.—M. Fouqué in the chair.—New researches on the action of hydrogen peroxide upon silver oxide, by M. Berthelot. The action of hydrogen peroxide upon silver oxide is regarded by the author as first resulting in the formation of an unstable silver peroxide, which then decomposes in two ways, partly into silver and oxygen, and partly enters into combination with some of the unchanged silver oxide present, giving an oxide Ag_4O_3.—On the representative power of a finite portion of a continuous curve, by M. G. Lippmann.—On the decomposition of meromorphic functions into simple elements, by M. Émile Borel.—On the roots of transcendental equations, by M. Edmond Maillet.—On the continued fraction of Stieltjes, by M. H. Padé.—On groups of operations, by M. G. A. Miller.—Action of the radium radiation upon selenium, by M. Eugène Bloch. A selenium cell submitted to the action of the radium rays undergoes a diminution of resistance of the same character as that produced by light or by the Röntgen rays, except that the effect is more slowly produced and that its magnitude is smaller. These experiments form an argument in favour of the idea that the radium rays are formed of a complex of kathode rays and of Röntgen rays.—Disruptive discharge in electrolytes, by MM. André Broca and Turchini. It is shown that the conductivity of electrolytes requires a certain time for its establishment, and that for sufficiently high frequencies electrolytes are pure dielectrics. This is in accordance with the requirements of the electro-magnetic theory of light.—On oscillating sparks, by M. G. A. Hemsalech.—The detection of alkaloids by the micro-chemical method, by M. E. Pozzi-Escot. The use of picric acid as a micro-chemical reagent for alkaloids, suggested by M. Popoff, is not found to form a trustworthy method, the only really characteristic crystals being given by strychnine.—On the flora of mosses in caverns, by MM. L. Géneau de Lamarlière and J. Maheu.—On the rational pruning of ligneous plants, by M. F. Kövessi.—On the probable existence of a recent sea in the region of Timbuctoo, by M. Aug. Chevalier.

DIARY OF SOCIETIES.

THURSDAY, April 25.

Royal Institution, at 3.—Naturalism in Italian Painting: Roger Fry.
Institution of Civil Engineers, at 8.—"James Forrest" Lecture—On Chemistry in its Relations to Engineering: Prof. Frank Clowes.

FRIDAY, April 26.

Royal Institution, at 9.—Colour in the Amphibia: Dr. Hans Gadow, F.R.S.
Society of Arts, at 8.—Polyphase Electric Working: Alfred C. Eborall.
Physical Society, at 5.—On the Thermodynamical Correction of the Gas Thermometer: Prof. Callendar, F.R.S.—On the Production of a Bright-line Spectrum by Anomalous Dispersion and its Application to the Flash-Spectrum: Prof. R. W. Wood.
Institution of Civil Engineers, at 4.—Repetition of "James Forrest" Lecture—On Chemistry in its Relations to Engineering: Prof. F. Clowes.

SATURDAY, April 27.

Royal Institution, at 3.—Climate: its Causes and its Effects: J. Y. Buchanan, F.R.S.

MONDAY, April 29.

Royal Geographical Society, at 8.30.—Travels in Central Kurdistan: Major F. R. Maunsell.
Society of Arts, at 8.—Alloys: Sir W. C. Roberts-Austen, K.C.B., F.R.S.
Institute of Actuaries, at 5.30.—On the Valuation of Staff Pension Funds: H. W. Manly. With Tables and Examples by E. C. Thomas.

TUESDAY, April 30.

Royal Institution, at 3.—Cellular Physiology: Dr. A. Macfadyen.
Society of Arts, at 4.30.—The British West Indies: Sir Nevile Lubbock, K.C.M.G.
Institution of Civil Engineers, at 8.—Annual General Meeting.

WEDNESDAY, May 1.

Society of Arts, at 8.—The Thames Steamboat Service: Arnold F Hills.
Entomological Society, at 8.—The Metamorphoses of *Æschna cyanea*, illustrated by Photographs taken from Life: Frederick Enock.—The Classification of a New family of the Lepidoptera: Sir George F. Hampson, Bart.
Society of Public Analysts, at 8.—Alkaline Waters from the Chalk: W. W. Fisher.—Citron Oil: Herbert E. Burgess.—Arsenic in Coal and Coke: Alfred C. Chapman.

THURSDAY, May 2.

Royal Society, at 4.30.
Linnean Society, at 8.—Studies in Heterogenesis: Prof. H. C. Bastian, F.R.S.
Chemical Society, at 8.—The Synthetical Formation of Bridged-Rings Part I. Some Derivatives of Bicyclopentane: Prof. W. H. Perkin, jun., F.R.S., and Dr J. F. Thorpe.—Ballot for the Election of Fellows.
Institution of Electrical Engineers, at 8.—An Instrument for Measuring the Permeability of Iron and Steel: C. G. Lamb and Miles Walker.—A Watt-Hour Meter: Frank Holden.

FRIDAY, May 3

Royal Institution, at 9.—Memory: C. Mercier.
Society of Arts, at 8.—Polyphase Electric Working: A. C. Eborall.
Anatomical Society, at 4.—(*a*) Additional Notes on the Articulations between the Occipital Bone, Atlas, and Axis in the Mammalia: (*b*) On the Development of Digits in Cetacea; (*c*) Observations on the Development of the Human Brain before and after Birth: Prof. Symington.—A Contribution to the Study of the Morphology of Adipose Tissue: Dr. H. Batty Shaw.—A Lantern Demonstration showing the Origin and Nature of the Hydatiform Bodies of the Testicle and Broad Ligament, with Special Reference to the Fate of the Mullerian Duct in the Epididymis: J. H. Watson.—Relation of Structure to Function, as illustrated by the Growth of the Inferior Femoral Epiphysis: Prof. Arthur Thomson.

SATURDAY, May 4.

Royal Institution, at 3.—Climate: its Causes and its Effects: J. Y. Buchanan, F.R.S.

CONTENTS.

SUPPLEMENT TO "NATURE."

DARWINISM AND STATECRAFT.

National Life from the Standpoint of Science. An Address delivered at Newcastle, November 19, 1900, by Karl Pearson, F.R.S. Pp. 62. (London: A. and C. Black, 1901.)

THE main purpose of this address is one which all thinking men, who desire the good of their fellow men, must respect, and many will heartily approve. Prof. Pearson presses upon his readers the importance to a nation of the possession by its constituent individuals of good strong brains as well as of good strong muscles, and of a well-directed training of those brains. He points out that the laws of heredity are as true for mankind as for farm stock or pigeons, yet that the result of modern civilisation is to remove or suspend the natural selection by which, in the case of non-social organisms, those individuals with inferior qualities would be prevented from obtaining success in the struggle for existence, and so hindered from largely contributing to the reproduction of the race. He points out that, on the contrary, accumulated wealth enables its inheritors to produce and rear large families without regard to the qualities of the inheritor, and that what seems to be a still more dangerous condition arises from the reckless and abundant breeding of the hopelessly poor and unsuccessful members of the community. The class which has the greatest mental endowment and is serving the nation best in all directions, marries late and produces few children. Deliberate selection in breeding and the restriction of the increase of worthless stock would, if such discrimination were within our limits of knowledge, produce definite results in mankind as it does in animals. But, in common with many other thinkers who have examined this question, Prof. Pearson does not see the way to any control of the reproductive function in civilised communities, though he does not seem to doubt, as I should do, that mankind would conduct these breeding operations with real success were the control to be tolerated. Where custom has introduced a system of restricting the size of families, as in France, Prof. Pearson tells us that unforeseen results follow, as, for instance, the relatively excessive increase of some section or racial division of the community which refuses to adopt the custom of producing only two children. The population of France, it is said, is becoming more and more largely composed of Breton stock in consequence of the production of large families by that race, whilst the rest of the population deliberately restricts itself. Prof. Pearson does not urge any attempt on the part of the community to interfere with the individual in this matter. It is, indeed, a matter which requires far deeper study than Prof. Pearson or any one else has yet given to it before conclusions worthy of the name of science, and so well founded as to justify practical measures, can be formulated.

On the other hand, in advocating a really wise and carefully considered *training* of such brains as the mixed stock of the community presents for manipulation, Prof. Pearson is on less doubtful ground. He justly points out that not only in our warfare in South Africa, but in commerce and manufacture, we stand in need of trained "scouts," men who have learnt to keep their eyes open and apply common sense, men *trained to observe and reason.* Our educational system fails to train the youth of the country in this way; it does not even aim at it or consider it. Training in what is called "natural science" or in scientific method is utterly neglected. As I have shown elsewhere, Oxford sets the example of neglect, and, naturally enough, that example is followed by each successively lower grade of school throughout the Empire. Prof. Pearson rightly insists that it is not mere knowledge of scientific results and formulæ which is needed, but the training which a proper study of a branch of science can give. The British parent foolishly and mistakenly says, "I want my son to learn what will be useful to him in his profession in life." Prof. Pearson has heard it over and over again in his capacity as a teacher, and I can, with a similar range of experience, fully confirm him. Never, says Prof. Pearson, does the British parent say, as he ought to say, "I want my son to know how to observe and how to think." The result of this almost universal misapprehension of the value and purpose of education is that where, after prolonged resistance, science has been forced into colleges and schools, it is perverted and degraded by the commercial purveyors of so-called education; it is represented by scraps of information supposed to be useful in engineering, brewing or medicine. Meanwhile the claim is openly made on behalf of the "humanities" (classical literature, philosophy and history) that they alone can give the training of the mind which is desirable over and above mere technical information.

It cannot, I think, be denied that this false issue has been raised by the advocates of the present antiquated course of study through which the average youth of England is slowly and fruitlessly dragged at Oxford and the great schools of the country. Partly through ignorance, partly through interest, here as in other great mechanisms which affect the welfare and the destiny of the British nation, a traditional, ill-considered procedure and a fruitless expenditure of power and opportunity are obstinately maintained and ruthlessly defended by those who find the present arrangements profitable to themselves and their class. With persistence, which is the index of either profound ignorance or overweening conceit, science is declared to be what it is not, namely, professional or technical information, and then it is asserted that science is useless as "training," and that "training" can be given by the traditional classical studies alone. The value of real education in science, namely, its training of men to observe and to reason, does not, of course, belong to the travesty of science, which is all that the educational ring of schoolmasters and college tutors have allowed to grow up in the system which they control. Prof. Pearson has my sympathy in his endeavour to persuade our fellow-countrymen that training in science is a necessary and vital factor in national prosperity, and that it is almost totally unprovided for in this country.

But I greatly fear that this is a case in which it is useless to address the democracy. It is waste of words to harangue the deaf; it is foolish to appeal to the eyes

of the blind. Germany did not acquire its admirable educational system by popular demand—nor does England owe such institutions as the College of Chemistry, the School of Mines, the Royal College of Science and the national art schools and schools of design to political agitators. Still less did the professional class of educationists help in either case—on the contrary, they bitterly and fiercely opposed these new developments. They are due in Germany to the Kings of Prussia; in England to the late Prince Albert. The only chance, it seems to me, which this country has for a change in the methods and aims of its education, and of its administration, which largely depends on the education of its administrators, is in the absolute conviction on the part of a great statesman, or, I say it with the deepest respect, of the King himself, that such change is of vital importance and is the one step necessary for the future welfare of the British nation. The crowd cannot guide itself, cannot help itself in its blind impotence. Here is the opportunity, the duty, of the greatest in the land.

Prof. Pearson's address was delivered at a time when the nation was suffering from the stress of war in South Africa. He has endeavoured to avail himself of the temporary awakening of the English people from their self-satisfied toleration of incompetence in order to press home the national need for the better training of its brains and the utilisation of the brains when trained. That is well-timed and legitimate. But when Prof. Pearson goes on to assert that the struggle between great civilised nations for territory, for trade-routes and for supremacy in manufactures—by warfare or by starvation—is the necessary condition, the moving power of human progress, he goes, I think, altogether beyond the conclusions which are warranted by our knowledge and beyond the indications which strictly follow from the application to this problem of the conclusions of biological science. He says:

"This dependence of progress on the survival of the fitter race, terribly black as it may seem to some of you, gives the struggle for existence its redeeming features; it is the fiery crucible out of which comes the finer metal. You may hope for a time when the sword shall be turned into the plough-share. . . . But, believe me, when that day comes mankind will no longer progress; . . . man will stagnate. . . ."

I do not hesitate to state, with a full sense of the gravity of the issue, that Prof. Pearson has no warrant in our present knowledge of the laws of development of animal societies or of human communities for this statement. This is certainly not a conclusion which can be for a moment pressed on popular acceptance as coming from the standpoint of science. It seems rather to originate in a hasty attempt to generalise from certain preliminary results of biology to conclusions in regard to an enormous unexplored field of human phenomena. I admit that the struggle between communities of human beings has resulted in the suppression of the more violent instincts of the individual and has led to the development, as an element of communal strength, of that quality which we know as human sympathy, to the elaboration of social instincts, of civic virtues, of pity and of principles of conduct. The list is Prof. Pearson's. But it has yet to be shown that there is any strict analogy between the struggle for existence of the countless individuals in each generation of a non-social species and the competition of great nations or great races of mankind. In the former case an immense number of variations is continually presented, and a remorseless destruction of all but the selected few. In the latter there is no great variation among the competitors on a given area and there is no destruction and consequent removal from reproductive perpetuation of the less successful community. The highly specialised communities of social insects might perhaps be fittingly dealt with in such prophecies as Prof. Pearson applies to mankind. It is, on the other hand, necessary to remember that the communities of human beings are far less individualised than are those of the insects referred to. One ant colony may utterly destroy another; one community of bees or wasps may exterminate its neighbour. But in the struggles of human communities in these later days the conquerors absorb and do not annihilate their competitors in those cases where there is any similarity of race. In these later days the struggle is for the supremacy of a special form of political organisation, and not for the extinction or the survival of a breed. Moreover, the new and strangely significant factor of oral and written tradition is operative in civilised communities, so that a race, though dead or merged in other races, yet continues to speak in the works of its greatest men.

Further, it seems to be beyond doubt that that progress of humanity, which consists in the production of those splendid individuals who have blessed their race by great discoveries in science and by great creations in art, is not in any way promoted, but is, on the contrary, hindered by the diversion of the energies and resources of the community to warfare and aggressive struggle. Just as the race of the jungle-cock cannot develop a nine-foot tail-feather when fighting its fellows as a struggling breed, but when removed from the restricting influences of natural selection bursts out in the Japanese poultry yards into such magnificent "sports," so humanity can only develop that "sport" which we call genius when it has reached social conditions of security and freedom from the demands of international warfare. Those nine-foot sports of the human brain which we know as Shakespeare, Newton, Raphael and Mozart were most certainly not traceable to the struggles of their native communities with other communities for territory, trade-routes or commerce. Rather, it would seem, were they and others like them only possible as the outcome of conditions when defence and offence were occupying but little of the strength and thought of their own and neighbouring nationalities. And there is this to be noticed by those who, like Prof. Pearson, would apply particular conclusions of biological science, without discrimination or reserve, to human society—viz. that whereas the corporeal "sports" of animal stock can only affect subsequent generations by the physical process of reproduction, the sports of the human mind—and, indeed, all individual minds and characters which rise above the herd—have, in consequence of the perfection of our records, an enduring influence upon vast numbers in the later generations, not only of one, but of all civilised communities.

I, for one, do not despair of humanity; I see no reason to suppose that what might be called "progress"

is impossible in the absence of bloodshed and international hostility. There is much ambiguity in the word "progress." A movement or change in human society which by some thinkers would be called "progress," would by others be called "retrogression," whilst others would deny the very existence of a change and see stagnation in place of either. Prof. Pearson, like other prophets of things to come, uses terms of conveniently vague significance. He should tell us more clearly what he means by "human progress" before he asks us to accept it as the end which justifies human warfare.

E. RAY LANKESTER.

Prof. Karl Pearson has for some years devoted his mathematical knowledge to a more exact co-ordination of observations on heredity. It cannot be said that in this address he uses any results of his study which were previously unknown to us through the observations of breeders of animals and the facts recorded by Mr. Galton. Prof. Pearson affirms that the "earlier interpreters of evolution" obscured it, and much of his address is devoted to pointing out that the association of individuals in a tribe made the development of human love and sympathy a necessity.

Now surely Huxley was the very earliest interpreter of evolution, and there was no part of the doctrine to which he devoted more attention than this very subject—evolution and ethics. But it is good that facts, however well known they may be to readers of NATURE, should be set forth strongly in an address which has a chance of coming before other readers.

The essential part of the address shows that a nation must be untiring and unresting in its efforts to increase its "brain" power; to increase its proportion of people of better brains and physique, if it is to hold its own against other nations. It is certain that we readers of NATURE are all in agreement with the author, and we are all in sympathy with him in his effort to rouse our sleeping nation, and to make it feel that the struggle for existence is not merely among neighbouring individuals, nor tribes, nor cities, nor counties, but among nations. We may go further, and say that every man of sense in the kingdom is fully alive to the fact that this struggle for existence is going on, and we only differ as to the best method of increasing the strength of our own people. There are many other things to be thought of, many things which Prof. Pearson's mere Aryan science cannot take into account. A nation, like a man or a field, needs occasional intervals of lying fallow. After national existence is secure, there is something important in the development of international friendship and affection. As care for the tribe preceded care for the nation, so care for the nation may only precede care for a federation of the nations. The struggle between some nations in Europe may be so bitter as to make them unfit for combination against a fitter Sclavonic and Asiatic federation. But these considerations must give place when our own nation is in such great danger as it is at the present time. Huxley and many others spoke of this danger and pointed out the remedy long ago, when the danger was remote; now it is coming swiftly upon us, and we can only repeat the same warnings and give the same advice in shriller and more vehement tones.

To show how we are continually saying the same things in regard to education, I would direct attention to "The Education of our Industrial Classes," an address delivered in 1883 by Sir Norman Lockyer, (Macmillan and Co.). At p. 16 I find the following words:—

"It is half a century since the Germans found out the importance of the new studies from a national point of view. We are now finding it out for ourselves, and finding it out not a moment too soon; and I need hardly tell you that the transformation which is going on is acknowledged to be one of the highest national importance. It is no longer an abstract question of a method of education; it is a question of the life or death of many of our national industries, for, in the struggle for existence, how can a man who wins his bread by the application of natural laws to some branch of industry, if he be ignorant of those laws, compete with the man who is acquainted with them? If for man we read nation, you see our present position."

The author, although he fears that our economic and social conditions are hardly ripe for such a movement, seems to favour Mr. Galton's notion that there ought to be social action towards an endeavour to prevent the inferior stock of people among us from breeding at will; making the all-important question of parentage a matter not of family, but of national importance. He points out that France is becoming a land of Bretons because the Bretons alone have large families, and that the feckless, improvident and brainless people in England among the very poor and the very rich have the largest families, whereas the provident people

"have been marrying late, have been having small families, have been increasing their individual comfort, and all this is at the expense of the nation's future."

This is why we are defeated commercially by Germans. He points out that a mere multiplication of centres of technical instruction will do no good against the American and German, as it is only where brains already exist that training is of use. He points out that nurture and education may immensely aid the social machine, but they must be repeated generation by generation; they will not in themselves reduce the tendency to the production of bad stock. He believes the Kaffir and Negro and Red Indian so low that they must be destroyed; that for a good stock of people to live alongside a bad stock, or to keep them as slaves, or to intermarry with them, is only to prepare a cataclysmal solution for the future.

It would, we think, be easy to prove, from the condition of mongrel races and from the history of the fall and rise of nations, that these statements are not the teachings of science; but let us suppose for a moment that he is right about England. During the French revolution a speaker declared, day after day, with vehemence, that the simple remedy for all French evils was "to kill all the scoundrels and traitors." Prof Pearson's remedy for all evils is to diminish the proportion of bad stock; but who are the people of England of bad stock? He himself confesses that they may be among the very rich as well as among the very poor; we are inclined to think that he would find much the same proportion among the middle class people, or Philistines, who "have been increasing their individual comfort."

He is specially wrong when he says that education will not improve the stock. On the contrary, we think that

it is by education alone, the education of the whole people, that such improvement can take place. Educated young people will so select partners that the stock will rapidly improve, and the improved stock will ask for better education still. What governor, however scientific, can so direct the choice of millions of different people as they themselves can if properly educated? for each case needs not only special scientific study, but something very much outside what we usually call science.

Whatever the stock, the author thinks—as we do—that it is only by education in scientific schools that, in a particular generation, a particular nation is made able to compete with other nations either in the arts of war or of peace.

Unfortunately, he leaves us in great doubt as to what he means by a scientific school. Over and over again he attacks the technical schools, which in this country are getting to be so numerous and which are improving in their methods every year. We feel sure that he cannot have studied this matter. He seems to think that the numerous great technical schools merely teach trade tricks and trade skill and trade formulæ. There are technical schools attached to all the great colleges and universities. There are the technical colleges of the City and Guilds of London Institute. He will find that in all these, students are instructed through experiment, through their own observation and through mathematical deduction, in those scientific principles which underlie their future profession. The wail of the teacher in such classes is always that his pupils have been so badly taught at school that they cannot observe, they cannot think for themselves, they cannot reason, they cannot even express themselves on paper; what they have learnt as mathematics is in no sense a part of their mental machinery and cannot be used in reasoning. The author says that for sixteen years he has himself been helping to train engineers, and he describes how he endeavours to make his students observe and think for themselves. And does not every teacher of mathematics or applied mathematics to engineers at all the other technical schools in the country try to do the same? Has he any kind of proof that they do not? It is quite true that at some colleges the teacher may have been badly selected, selected merely because he took a good place in the mathematical tripos, a man with no liking or aptitude for teaching; but we beg to assure Prof. Pearson that such men are the exception, and not the rule, at the technical schools with which we are acquainted. Unfortunately, at all these colleges the teachers find many, or indeed most, of their pupils unprepared for the higher, more complex work which some years hence will, we hope, really be taken up by all students in these schools and colleges. And so it is that many engineering students, like Prof. Pearson's pupils, after they leave college "adapt themselves to an environment more or less different from that of the existing profession." If these young engineers had been brought up from early youth to observe and think for themselves, there would be no need to teach them the most elementary principles of "scouting" at the ages of eighteen to twenty, when, in truth, they ought to have already entered the practice of their profession. True it is that for these ignorant young men the very simplest scientific apparatus may serve; but there are some students who have already been trained to scout, who come prepared to be taught under our contemptible "brand-new system of technical instruction," and it is for them that we have our ridiculously unnecessary "physicist with palatial laboratory and elaborate and costly implements" and that there exists "the biologist with his 80*l.* microscopes and specimens drawn from the four quarters of the globe." Surely Prof. Pearson must see that the education which we all know to be so necessary for the development of the faculties ought to be begun in early youth, that there is at present no genuine education in English public schools, and that without physical science such an education cannot be given.

It is not alone the teacher in a technical college who complains of the absence of education in the public schools. Whether they apply themselves to commerce or manufactures, whether they enter one profession or another, whether they try to become diplomatists or statesmen, our boys are found to have had no education. In days when all Europe was at war and we were safe in our island, our grandfathers gathered to themselves all the good things of the world, and now we are living on their legacy. And we are blind to the fact that the lean and hungry nations, covetous, cautious and disciplined, are almost quarrelling already over us, their prey. If there are enough honest and thinking men in England this day they will speak to England loud enough to stir her out of her apathy; or if not, and if England cannot be so stirred, let her descend to her natural position; let the stranger come in and divide her property; even the property of those men who are selfishly silent. Our cry is for education and only that; true education for everybody, from the highest to the lowest, is a national necessity more important than any weapon of war or any political machinery for the repression of bad stock, because education will give us all these things and much more.

JOHN PERRY.

THE DISCOVERER OF LAKE NGAMI.

William Cotton Oswell, Hunter and Explorer. By his son, W. E. Oswell. Two volumes. (London: W. Heinemann, 1900.)

SO far as the general public are concerned, the interest in the career of the late Mr. Oswell may be said to begin and end with the period (from 1844 to 1852) during which he made his five expeditions to Africa, at a time when by far the greater portion of that continent was still a *terra incognita*. But this period of the life of the great explorer and hunter occupies only a comparatively small portion of the two volumes before us, the bulk of which is taken up by an account of the parentage and early years of Oswell, and with letters to his family and friends. However interesting these may be to his immediate relations, we venture to submit that they appeal but slightly to the general public; and, in our opinion, the author would have been much better advised had he condensed his narrative into the space of a single volume of the bulk of one of the two under notice.

Apart from this, the author has discharged a task of considerable difficulty and delicacy (for it is never an easy matter for a son to write the biography of his father) in a highly creditable and satisfactory manner.

Until the appearance in 1894 of his chapters on hunting in Africa (written, after much persuasion, at the instance of Sir Samuel Baker) in the "Big Game" volume of the *Badminton Library*, the world knew practically nothing of Oswell's South African explorations and experiences, except what can be gleaned from Livingstone's "Missionary Travels."[1] The information given in the present volumes, though far less full than could be desired, tells the story of his adventures in considerably more detail than is the case in the articles referred to, and its publication is therefore a distinct gain to our knowledge of the early days of African exploration.

Oswell's persistent refusal to take any share in the honours attaching to the discovery of Lake Ngami, and his self-abnegation in permitting nothing from his own pen to forestall the appearance of Livingstone's volume, are now matters of history, and are alluded to in some detail in the introduction by Mr. Francis Galton to the work under review. But there can be no hesitation in admitting that as Oswell originated the idea and fitted out the expedition at his own cost, the honour and glory of the discovery should by rights have been his and his alone. Indeed, this is practically admitted by Livingstone himself. And here it may be said that we are not for a moment casting the slightest reflection on the great missionary explorer. The account of the discovery of Lake Ngami had to be written and published, and as Oswell refused to undertake the task it was the bounden duty of Livingstone to do so. The destruction of his own journals by Oswell, in case they should be published before the appearance of Livingstone's work, is, however, a matter which must always remain one for serious regret.

In this connection, it may not be out of place to mention that there is a discrepancy between the accounts of Livingstone and Oswell as to the precise date on which the great lake was discovered. Livingstone[2] states that "it was on the 1st of August [1849] that we reached the north-east [or lower] end of the Ngami." Oswell, on the other hand, as quoted on p. 201 of the first volume of the work under review, says that

"We started on the 16th of July, and after twelve days' march arrived at the half tribe of the Bamanguato, who call themselves Batouani. We outspanned nearly abreast of the town at the lower end of the Lake."

This would make the date of its discovery July 28. It is, of course, a matter of slight moment, but it would be interesting to find whether original manuscripts throw any light on the reason of the discrepancy.

It is to the African adventures of Oswell that our remaining space will be restricted. Several of his encounters with, and escapes from, wild animals mentioned in the present work have been already narrated in the *Badminton Library*, from which the illustrations have been reproduced. These latter were drawn by Joseph Wolf under the personal supervision of Oswell himself, and may be taken to be as truthful representations of the actual scenes as could be obtained without the aid of photography. It must, however, be confessed that, either from the wearing of the blocks or from the fault of the printer, the reproductions are by no means equal to the original plates. This inequality will be manifest if the plate facing p. 16 of vol. ii. of the work before us be compared with its prototype facing p. 128 of vol. i. on "Big Game Shooting" in the *Badminton Library*.

Like Cornwallis Harris and his own companion, Frank Vardon, Oswell was in the service of the Hon. East India Company, although in a civilian instead of a military capacity, and it was ill-health in India that led him to recruit his energies in the Cape. Both on his first expedition with Murray, and on his second with Vardon in 1844 and 1845, Oswell, to quote his own words,

"penetrated far beyond the utmost limits of previous geographical knowledge, exploring, hunting, revelling with them in shooting such as no men ever had before or will ever have again, the first Europeans and the first guns among the myriads of animals."

His acquaintance with Livingstone commenced in 1845 and continued till the death of the latter. On his return to Africa in 1848 from a short sojourn in India, the great expedition to Lake Ngami was organised and brought to a successful conclusion, his companions being Livingstone and Murray. The triumph of the march was the crossing of the Kalahari desert, for when the Zouga—the effluent of Ngami—was reached, the difficulties were over, and patience and perseverance were alone necessary. The fourth expedition, undertaken alone, was mainly occupied in shooting on previous routes; but in the fifth, which was undertaken with Livingstone, the course of the Zambesi and its tributaries was mapped for the first time, and the myth that the former discharged at Delagoa Bay disposed of for ever.

Although, unfortunately, neither of the quartet was a naturalist in the true sense of the term, their expeditions largely extended our knowledge of South African animals. During the third expedition, those beautiful antelopes the lichi (*Cobus leche*) and puku (*C. vardoni*) were discovered; and it seems that Livingstone or Oswell were really the discoverers of the nakong, or situtunga antelope, or, at all events, of the Chobi representative of the same, although the animal was named from specimens brought home at a much later date by Speke. A rhinoceros was also named after Oswell by Gray, being regarded as distinct from *Rhinoceros simus* on account of the forward direction of the front horn, which is always worn at the tip by being pushed along the ground. Later writers, and even Oswell himself, have, however, denied the distinctness of this form. But Oswell's notes tell us that the quebaaba—as this animal is always called by the natives—was never found below the southern tropic. If it had been the sole white rhinoceros north of the tropic, it would have undoubtedly been entitled to rank as a local race. And even as matters now stand its true affinities are worth the attention of naturalists.

Another piece of information afforded us by Oswell's notes is the fact that elephants from different localities in South Africa present certain points of difference. He says, for instance (vol. i. p. 205), that on the Zouga "the elephants are a distinct variety from the Limpopo ones; much lower and smaller in body (10 feet is a large bull), but with capital tusks." This also is worthy the best attention of zoologists, although it is to be feared that it is now late to differentiate local races of the species, if such

[1] In the popular edition of that work, published in 1861, Oswell's name is not even mentioned in the index, although it occurs on certain of the plates.

[2] *Op. cit.* p. 46.

really existed.[1] It is to be regretted that before making the statement (vol. i. p. 219) that a pair of gemsbok horns obtained by Oswell, which measure 44 inches, are the longest but one on record the author did not consult some recent works on horn-measurements. Had he done so, he would have found that these dimensions are exceeded by five examples, the "record" length being $47\frac{1}{2}$ inches.

Of the profusion of great game in Central South Africa in Oswell's time, and of its subsequent extermination, the story has been told so often that its recapitulation here would be superfluous. Whether Oswell and his successors were altogether free from blame in regard to indiscriminate slaughter is a question which it is not our province to answer on this occasion. He himself wrote, somewhat pathetically, in after years as follows: "I am sorry now for all the fine old beasts I have killed, but I was young then, there was excitement in the work; I had large numbers of men to feed; and if these are not sound excuses for slaughter, the regret is lessened by the knowledge that every animal I shot, save three elephants, was eaten by man, and so put to a good use."

That Oswell was a gallant and noble-hearted gentleman, as well as a true sportsman, will, we think, be the verdict of all who read a very attractive, albeit in certain respects a somewhat saddening, book. R. L.

[1] Since the review was written Dr. Matschie, of Berlin, has proposed to split up the African elephant into several so-called species.

THE WORKS OF C. F. GAUSS.

Carl Friedrich Gauss Werke. Achter Band. Pp. 458. (Leipzig: Teubner, 1900.)

THE contents of this volume consist mainly of reviews, correspondence and a series of posthumous fragments relating to various branches of pure mathematics. It not unfrequently happens that a mathematician's unfinished essays, only brought to light after his death, are even more stimulating than the finished works which he published during his life. This is especially true of Gauss. As he says himself in one of his letters, he aimed at the utmost perfection of form; he worked, as it were, in marble, and did not give his masterpieces to the world until they had been elaborated to the highest degree of symmetry and polish. The result is that, when we study the productions of his genius, we feel a kind of awed admiration which is not entirely free from a sense of chill; his stately synthesis compels our assent, but does not always attract our sympathy, and rarely suggests the idea of even the humblest emulation. Gauss's own countryman, Jacobi, in his lectures on the theory of numbers, refers with a touch of bitterness to the frozen austerity of Gauss's demonstrations.

Much, then, as we may deplore the fact that Gauss's official duties, as well as his fastidious habit of composition, prevented him from working out the details of so many of his great ideas, there is a certain consolation in being able to see, in the notes which have been preserved, some traces of the inception of his far-reaching discoveries. There is no need now to emphasise the extraordinary way in which he anticipated many of the most important results obtained by other men. We can understand the suspicion and incredulity with which his claims were regarded by some of his contemporaries; but no one can doubt the extent and independence of his researches in the theories of elliptic functions, of modular functions, and of non-Euclidean geometry, not to mention other things. It must have been very trying to him to see so much of his work forestalled, so far as priority of publication was concerned; and on the whole it may be said that he betrayed less disappointment than might have been expected. It is true that in this volume there are letters of a rather controversial kind, in which he emphatically claims priority in the discovery of the method of least squares; but he refers appreciatively to Legendre's work on cometary orbits, adding pathetically,

"Es scheint mein Schicksal zu sein, fast in allen meinen theoretischen Arbeiten mit Legendre zu concurriren."

And in writing to Bolyai (a friend, it is true) about the non-Euclidean geometry, after saying that his many engagements prevent him from thinking of the subject for the present, he continues:

"Es soll mich herzlich herzlich freuen, wenn Du mir zuvorkommst, und es Dir gelingt alle Hindernisse zu übersteigen. Ich würde dann mit der innigsten Freude alles thun, um Dein Verdienst gelten zu machen und ins Licht zu stellen, so viel in meinen Kräften steht."

The letters and notes on the foundations of geometry form one of the most interesting sections of this volume. It is clear that before the end of 1799 Gauss had critically examined the theory of parallels, and begun to doubt its necessary truth: he says that he could prove the whole of geometry if it could be shown that a rectilinear triangle is possible, the area of which exceeds that of any given surface; but that, far from assuming this as an axiom, he thinks it may be possible that, however great the sides of the triangle are taken, the area is less than a certain fixed quantity. He returned to the subject from time to time during many years. It appears from a letter of Gauss to Gerling, dated March 16, 1819, that he had then obtained some of the principal results in that species of geometry in which the sum of the angles of a rectilinear triangle is less than two right angles, for he gives the formula

$$\text{“Limes areæ trianguli plani} = \frac{\pi CC}{\{\log \text{hyp}\,(1+\sqrt{2})\}^2}\text{,”}$$

where C is a certain constant determined by the space under consideration. Gauss refers again to this constant in a letter of November 8, 1824, and speaks of it as "a definite (an sich bestimmte) linear magnitude existing in space, although unknown to us." This is not very clear, and the context does not enlighten us, in spite of its criticism of the philosophers. The fact is that Gauss nowhere (apparently) in these fragments expresses himself with perfect clearness about this constant. He had arrived at the notion of an upper limit to the area of a triangle; but he never suggests the possibility of an upper limit to the distance between two points, and, in fact, assumes that there is none. Moreover, he dismisses without sufficient consideration the question of how such a thing as an *absolute* distance is conceivable, and ignores the fundamental difficulties which beset the application of number to measurement. It is very remarkable that so

consummate an analyst failed to realise completely that no strict mathematical theory of the metrical properties of space is possible until the elements of space have been brought into correspondence with a definite arithmetical manifold. One such manifold is the field of analytical points (x, y, z) used in ordinary algebraic geometry. Its metrical properties admit of analytical definition, and are capable of exact determination. They apply to "real" space in so far as they belong to a system suggested by intuitions of sense, and therefore necessarily associated with intuitional experience. But no intuition can give a complete theory of space; and the question whether "real" space is Euclidean or non-Euclidean is one that, from the nature of the case, cannot possibly be answered, and it may even be doubted whether it has any meaning at all.

Some of Gauss's remarks on the metaphysics of space are extremely interesting, even though they may not, to every one, carry complete conviction. Thus, he says, "Der Unterschied zwischen Rechts und Links lässt sich nicht definiren, sondern nur vorzeigen," and proceeds to assert that the distinction can only be indicated by one intellect to another by means of a material object. He then says, in conclusion, that he finds in this a striking refutation of Kant's notion that space is *merely* the form of our outer intuition ("Der Raum sei *bloss* die Form unserer aüssern Anschauung"). It is difficult not to see in this both vagueness of reasoning and a misapprehension of Kant. If "right" and "left" are terms used to indicate a distinction apprehended by sense, Gauss's statement is so obvious as not to be worth making; but when they are applied to relations of position in a mathematical space they *do* admit of definition, not absolutely, but as correlative terms. And even from the first point of view there is nothing in the fact to which Gauss calls attention which is inconsistent with Kant's assertion that space is a form, or scheme, in terms of which we interpret (or into which we fit) certain related groups of our sensuous impressions. This pre-Kantian attitude of Gauss is illustrated by other allusions to the "reality" of space. But it should be noticed that he expressly says that since a geometry of more than three dimensions can be considered *in abstracto* without contradiction, even though we have no corresponding intuitions, it is possible that such a geometry is accessible to beings of a higher order. He hopes, too, that in another life he may be able to see more into the essential nature of geometry.

The rest of the volume must be dismissed with a very few words. From the notes on elliptic transcendents it is clear that Gauss not only inverted the general elliptic integral, but expressed the result as the quotient of two integral functions: that his work on the arithmetico-geometric mean led him to the group of linear transformations of the period which leaves the modulus κ^2 unaltered; and that he represented this group geometrically, actually drawing a figure for the fundamental triangle and a few of its derivatives. A letter to Bessel, dated December 18, 1811, shows him to be in possession of the principles of complex integration. There is a considerable series of notes on the analytical theory of surfaces, most of which was incorporated in the famous memoir; applications of complex numbers to geometry, and especially to transformations of space, on which there are two short but very suggestive notes; a fragment on knots, with a very convenient notation, and a complete table of different knots with less than six crossings; and finally, there are notes on the barycentric calculus, with a formula $B - C = ai$, curiously like Grassmann's notation in the *Ausdehnungslehre*. These seem to be the most important items; several, which are of less interest, have not been mentioned.

G. B. M.

CHINESE AFFAIRS.

China: Her History, Diplomacy and Commerce from the Earliest Times to the Present Day. By E. H. Parker. Pp. xx + 332. (London: Murray, 1901.) 8*s.* net.

CHINA is an inexhaustible subject, and though we have lately had books in abundance on modern affairs and the present crisis, there is still room for such a work as Mr. Parker's "China." It aims at a great deal more than an account of current politics, and supplies a whole army of facts and statistics on the history, trade and government of the Empire. The chapters on the history will be found valuable. They are full of information, and will well bear a careful study. But the later portion of the work, beginning with the introduction of foreign trade, will probably be found the more generally interesting part. Mr. Parker opens this section with the life and trade at Canton, where British merchants were "cabined, cribbed, confined" in what was known as the "Factory."

"The merchants," he tells us, "passed a confined, ceremonious and reserved existence, entirely in the hands of their *Fiadors* and *Compradores*, on the one hand, and of the Chinese Cohong on the other. No wives were allowed, and even burials had to take place at Whanpoa, twelve miles down the river. It was only in 1828 that the British superintendent first succeeded in getting his wife up. British trade was, of course, the largest of all; lead (for packing tea) and woollens were the chief imports (no specie, no cotton fabrics) from England, opium from India, and the usual 'Straits' produce picked up from the Dutch colonies visited by our ships *en route*. Tea and silk were the main exports then as now. The British tea consumption in 1795 was 14,000,000 lbs. a year, more than one-half of which total was smuggled by foreign ships from Canton operating in the English Channel."

Since those days a complete change has come over our trade. India and Ceylon have competed so successfully with China in the production of tea that, whereas in 1880 2,100,000 cwt. of the leaf were exported from China, only 1,631,000 cwt. left the country in 1899. But while this export has thus diminished, certain new imports have been greedily accepted by the people. Kerosene oil is one of these. Before 1880 little was heard of it in China, while in 1890 more than a hundred million gallons were imported. On this and other articles of trade, Mr. Parker writes:—

"Mules may be seen by the thousand in distant Bhamo carrying kerosene oil through the passes into Yunnan; peasants may be met every evening in arcadian Hainan carrying home a neat pound bag of beautiful white flour, together with a farthing's worth of periwinkles their ancestors have always brought home of an evening as a relish for their rice. An immense trade is done in old English horse-shoes, which are considered the best iron in the world for making small

household articles, such as brackets, hooks and bolts. I have seen steamer after steamer disgorge this paying and useful ballast at Shanghai. Another revelation is the commercial capacity of the Bombay yarn . . . of which Japan also, who now sends her own yarn and piece goods to China, for some years imported annually one million sterling's worth. The trade in arms and ammunition has enormously expanded, chiefly in the hands of the Germans, who are now receiving an unpleasant reminder that this particular activity is apt to cut both ways."

Mr. Parker speaks, and speaks justly, of the honesty of the Chinese merchants, and has something to say for the honesty of the people generally. But, like the sale of arms, his argument on this subject cuts both ways. He assures us that he never lost anything of value while in China. This may perhaps be accounted for by the facts that he always kept his safe locked, and that he possessed no jewellery but that which he habitually wore on his person He incidentally mentions also that on one occasion he asked his "boy" how it was that so many of his forks had a stain. To which his "boy" replied that it had been done by

"various coolies or underservants, each of whom in succession invariably tested the electro on his own account, merely as a businesslike act."

On another occasion, when he wished to lock up the same electro box, he (the "boy") said :—

"Not at all ; if you lock it up, some one will mistake the contents for silver, and carry the whole box away or break it open ; whereas, if you leave it open, each thief will be able to ascertain for himself that it is not worth stealing."

The only time, he tells us, that he suffered any depredation was when a thief, at an inn, carried him and his bed to a convenient spot, and extracted a valuable fur coat from beneath him, without disturbing his slumbers. Altogether his chapter on the national characteristics of Chinamen is amusing reading, and all the more so since, quite unconsciously, he assumes throughout his remarks on the subject the attitude of the "Devil's Advocate."

ANTHROPOLOGY IN ITS SCIENTIFIC AND EDUCATIONAL ASPECTS.

Anthropologie als Wissenschaft und Lehrfach. By Dr. Rudolf Martin. Pp. 30. (Jena : Fischer, 1901.)

THE inaugural lecture delivered by Dr. Martin on the occasion of his appointment to the newly founded chair of anthropology in the University of Zürich may be described as a survey of the present state of anthropological science, together with some most opportune suggestions regarding anthropology as an instrument of education. After a few remarks on the gradual process by which anthropology has acquired a position of independence among other sciences, the author turns to the range of subjects now studied under the title of anthropology, and, in the first place, draws a strong line of distinction between the physical and the psychical aspects of that science. With the former are placed the sciences of physiology and pathology, while the latter division is taken as applying, in the first instance, not so much to the psychology of the individual as to that of various groups of humanity judged by their culture and social status. With the latter, the psychical, division there must be ranked the studies of archæology and of prehistoric anthropology. The distinction of the classifications of mankind based on the two great divisions of anthropology respectively is strongly insisted upon, and the methods of anthropologists call for some words of warning in this connection. The aims laid before future workers by Dr. Martin are, so far as regards the methods to be employed, a rational, systematic and uniform use of numerical data ; at the same time, we are reminded of instances that have occurred in past years of misapprehension of the true significance of the results of such methods, and are warned of the necessity of exercising the greatest care in judging similar results in the future. With particular reference to the classification of human races on physical grounds, the necessity of employing, not a single character, but a combination of features as the criterion of differences is dwelt upon at some length, and the urgent need for immediate action in the case of primitive races now fast dying out is also clearly expressed. The first part of the essay concludes with suggestions as to the lines of investigations to be pursued in the case of mixed races, and with a firm insistence on the importance of an intimate knowledge of the anatomy of the mammals of the order Primates, to those who work at the physical side of anthropology.

Dr. Martin then proceeds to discuss the place of anthropology in University teaching, and while considering that it must be studied in connection with what we may call unapplied sciences (his precise expression is "the mathematical and scientific section of the Philosophical Faculty," for which we have no exact equivalent in English universities), he is well aware of the advantages conferred upon those working at the physical side of anthropology by a knowledge of the elements of medical science, and, above all, of human anatomy as studied in the dissecting room. A place is therefore claimed for anthropology in the education of every professional man, but more particularly for those who teach in the higher schools, for medical men, and last, but not least, for those who hold administrative or other posts in colonial possessions. The application of anthropological methods to the identification of criminals is also mentioned. Finally, there are pointed out the claims of anthropology to figure as part of a liberal education, independently of any professional application of its results, and we are reminded of the deep significance of the attempt to realise, in its fullest sense "man's place in nature."

The foregoing notes will, it is hoped, convey an idea of the scope and purport of Dr. Martin's lecture. It may be mentioned that Dr. Martin, besides being the author of important contributions to anthropology both in the laboratory and in the field, is deeply versed in philosophical studies. His opinions on the methods and aims of anthropology will be received with all the greater consideration by those who are interested in the future of that science. In a single lecture it was manifestly impossible to do more than indicate the chief points and we think that Dr. Martin has not overlooked any of great importance. From this point of view we think that the essay constitutes a valuable survey of the subject and that it appears very opportunely at the commencement of the twentieth century. W. L. H. D.